

# SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1914 by Munn & Co., Inc.

VOLUME LXXVII  
NUMBER 2003

NEW YORK, MAY 23, 1914

[10 CENTS A COPY  
\$5.00 A YEAR]



SMALL TEMPLE CONNECTED WITH THE NUNNERY RUINS AT CHICHEN ITZA.—[See page 328.]

The Iglesia or Church is a small one-roomed temple with a flying façade (front wall elevated one story above the roof), which is clearly made of reused materials. The flying façade is ornamented with three mask panels.

# House-Flies and Disease\*

## The Attack on the Fly must be Levelled at the Breeding Places

By Edward Halford Ross, M.R.C.S., L.R.C.P.

WHEN the history of present-day medicine comes to be written, the opening of the twentieth century will probably be labeled as the beginning of the era of disease prevention. In the past doctors have been engaged almost wholly in trying to cure disease; they have been occupied in alleviating individual cases of suffering. But during the last few decades a new idea, a new thought, has arisen, namely, that prevention is better than cure. It was Edward Jenner who pointed out this path a hundred years ago. And now we are beginning to regard disease as an armed enemy ever standing on the threshold of an unarmed homestead; we must learn a way to shut the door in his face rather than try to attack him when inside. Jenner discovered the means of preventing smallpox; and now, a century later, we can say that the disease can be eradicated with certainty from civilized communities. This is disease prevention on the wholesale plan, and it is rapidly replacing the other attempts at retail cure.

In the middle of the last century Science published a series of romantic discoveries. She chose the time when the world was racked with wars and the alarms of wars. She told the stories quietly, and showed how Nature can, if she wishes, destroy more human lives in a few weeks with a minute microscopic germ than we can in all the battles ever waged and by the most perfect of our implements of war—battleships, guns, torpedoes, and even flying machines. She can do more damage in a series of epidemics of typhoid fever or plague than Napoleon or Alexander did in all their punitive expeditions. Moreover, she does it very easily, very quietly, and very simply.

It was Pasteur who first brought forward this knowledge. He discovered that the tiny bacteria are one of the chief causes of disease, and he was the first to apply this knowledge practically and to prevent the scourge of disease among silkworms. As a result the silk industry of Lyons flourishes to-day better than it ever did before, though at that time it was in danger of extinction. This was the beginning of modern medicine, and his discovery was extended to human maladies. Pasteur was thus the first to show that in order to prevent a disease it is essential to find out accurately the whole of its natural history—that is, every detail of the life of the germ which causes it must be understood; and then, and then only, can we deal with it certainly and successfully. We must discover the vicious chain of the life-history of each parasite which causes disease, and when we have done this we must knock out a link and so prevent its accomplishment.

Very soon after Pasteur, Sir E. Ray Lankester found that a different kind of parasite, a protozoan as it is called, which lives a complex life in the blood of various animals, also produces diseases in them; and he showed that certain definite affections may be caused by these protozoa as well as by bacteria. Here are the twin discoveries on which our modern medical knowledge is based, and of which the human race is now reaping the benefit.

Following the publication of these, progress in bacteriological and protozoological research was rapid. Koch in 1881 found the germ of consumption; Eberth and Gaffky that of typhoid fever; Hansen that of leprosy; Kitasato that of plague; Laveran in 1882 discovered the cause of malaria or ague as being a blood protozoan; and about the same time attention was drawn to a group of minute tailed swimming parasites known as trypanosomes, which are frequently seen in the blood of various animals, and believed to cause disease in them. Some of these have recently been convicted of causing sleeping sickness and other allied afflictions of the tropics.

But the discovery of the causative agent of a disease is not in itself sufficient to enable us to prevent that disease. We must know more. It is essential to know exactly how the germ is conveyed from one person to another, or from one animal to another, or from animals to human beings, as the case may be. As stated before, it is necessary to know the whole story of the disease, and our knowledge must be complete. And nearly twenty years passed before we could prevent any of these diseases, although we knew the causes of them.

Then a most important fact came to light. It was found that insects may and do transmit disease germs from man to man, and from animal to animal, and from them to man. This discovery, like most discoveries, was the outcome of an evolution of thought; a number

of thinkers working independently seemed to come suddenly to the same conclusion, and there followed some practical work, observations and experiments, which led to proof; and that which before was mere suggestion and conjecture became a certain knowledge, a proven fact.

As a result of five years' work in India my brother, Sir Ronald Ross, showed conclusively that the parasite of malarial fever, which had been discovered by Laveran in the blood of human beings suffering from ague, was transferred from human being to human being by a certain kind of mosquito. And this discovery has opened the way leading to the reclamation of the tropics. As a result, many of those places which were formerly labeled as white men's graves are now described as white men's homes; health, industry, progress have replaced constant sickness, disease, death.

The story of this discovery is one with which you are all probably familiar. It will bear telling again briefly. The complex parasite of malaria lives and multiplies in the blood of men, women and children, inhabiting marshy, fever-stricken districts in the tropics and sub-tropical climates. It was frequent in England, but has been abolished by the reclaiming of the Fens and by improved sanitation in rural swampy regions. If a kind of mosquito or gnat indigenous to such places bites and sucks up the blood of a fever patient and swallows one or more of the germs, these undergo a series of changes, or metamorphoses as they are called, within the body of the insect; they develop through the stomach wall, and ultimately appear in the saliva of the mosquito, and again infect any human beings who may be subsequently bitten. Thus the whole natural history of the causative agent of malaria was discovered, and, therefore, this essential knowledge led to the prevention of the disease. The habits of the mosquito were known. These insects lay their eggs on the surface of marshy water. From the eggs, tiny, wriggling fish-like larvae appear; and after ten days in the water mature mosquitoes are born from them, and begin their flying, pestering, dangerous lives in the air. Only the female gnats bite, but these are sufficient to convert whole towns and villages into veritable death-traps.

Formerly the only known way of dealing with malaria was to try to prevent it by curing every case of fever; but all attempts at this were elaborate failures. Doctors can cure malaria easily by quinine. One would have thought, therefore, that if every person in a town or village took quinine regularly the disease would be stamped out. At Ismailia, in the old days, the Suez Canal Company tried this means of prevention. It was one of the most perfect endeavors of its kind. Ismailia, a town of which I was health officer for five years, is a little place of 10,000 people situated in an oasis of the desert, and on the bank of the Suez Canal. It is completely shut off on all sides from the outside world by forty miles of sand. Malaria appeared there, having been introduced by Bedouins and by some Italian workmen from the Roman Campagna. The mosquitoes were breeding in a series of shallow Nile-water marshes, which had been allowed to develop owing to the ignorance of the nature of this disease. And in a short time after the opening of the Suez Canal the disease ran rife, and soon racked and decimated the place.

The Suez Canal Company were at their wits' end. Here was the town which they had determined to make the chief port of the Suez Canal being founded before their eyes. And, knowing little about malaria in those days, they could do nothing. But they made this attempt to prevent the disease. They had absolute control over every man, woman, and child in the place; for Ismailia contained only their employees. They gave orders that everyone was to take quinine regularly. They opened dispensaries, built a magnificent hospital on high ground. They enforced the administration of quinine. But still the fever went on. There was a slight reduction, but that was all. The truth was, that so long as a man was ill he would take the quinine they gave him; but as soon as he felt better he threw the pills away. As a result, malaria remained, the government was removed to Port Said, the law courts to other towns in Egypt, people became frightened, and the Suez Canal Company were left to see their ambition, "the inland city of the seas," as Ferdinand de Lesseps called it, becoming a sepulcher, a city of the dead.

Here, then, was an attempt to prevent disease by curing it; but it failed. Yet the experiment was a perfect one. The company had absolute power over the

place. If any inhabitant refused to take quinine regularly his pay was stopped. And although there was complete financial control, still the disease went on. It serves to show that the method was faulty, and that we cannot eradicate a disease by curing individuals who are attacked by it. This experiment is of great interest, because it has recently been suggested that another great scourge in England might be prevented by notification and enforced cure. If the Suez Canal Company failed to do this with malaria at Ismailia, where the conditions were more favorable, inasmuch as they had complete authority over the people, we are sure to fall here where such control is impossible.

It was not until a more scientific method of preventing malaria was discovered, until, indeed the whole natural history of the disease germ was known, that the disease was abolished from Ismailia. But as soon as the knowledge of the part played by the mosquito was found out steps were taken to prevent these insects breeding in and around the town. And as a result, the disease vanished in a few weeks where it had raged for twenty years. The marshes were filled up or drained, stagnant pools flushed out every week, and puddles regularly oiled. In consequence, mosquitoes have gone from Ismailia, and with them has gone the fever. Ismailia is now the healthiest town in Egypt; but it has never recovered the blow that malaria dealt it. Port Said, forty miles away, has taken its docks, its wharves, coal-sheds and shipping, its business and importance, and the city of imagination and ambition does not exist. Instead, there is a picturesque little hamlet nestling among its palms, gardens, evergreens, roses and lilies, divided by long marked out boulevards and terraces, squares and public places never to be built. One sees there an Avenue de l'Impératrice and a Rue Nationale with nothing but workmen's cottages in between: It is a silent little town and the streets are empty. The Arab looks about him and wonders, "El turba en'adeefa" (a cleansed tomb) he calls it, and passes on. But it is healthy and clean, and disease knows it no more.

Ismailia is an example of the successful eradication of disease by modern methods of scientific research. It was quickly followed by others. Sir William Macgregor, then governor of Lagos, applied the knowledge gained to West Africa. Hong Kong, New York, and Havana, the Federated Malay States, all told the same story that the reduction of the conveying insects resulted in the prevention of the disease. Malaria can now be abolished.

Then it was discovered that yellow fever is also conveyed from human being to human being by mosquitoes. The researches by which this discovery was made are most brilliant. They were carried out by an American Commission, the members of which allowed themselves to be bitten by mosquitoes which had fed on yellow fever patients, and in consequence they contracted the disease. One doctor died. His name, Lazear, must be recorded with those of the other martyrs to medical science. But should we will it, yellow fever could also be a thing of the past.

As a result of this discovery of the insect transmission of disease, therefore, we have a healthy Suez Canal, Havana, New Orleans, Port Said, Malay States, Rio, and many another, as well as that eternal monument to scientific medicine, the Panama Canal.

The mosquito having been found out, the next obvious thought was the house-fly. Serious attention was first drawn to this insect as a possible disease carrier during the South African and Spanish-American wars. It was during these expeditions that the part played by house-flies in the spread of typhoid fever became obvious; it had often been suggested before. But during these wars the camps, soldiers' lines, horse lines, and kitchen tents were fly-infested. The flies used to cover every article of food, and the tents were rendered almost uninhabitable by them. During the American war in Cuba one-fifth of the soldiers contracted typhoid fever, and the prevalence of the disease (typhoid or enteric fever) among our officers and men in South Africa, with the Bloemfontein epidemic, will be remembered by every one. Although drinking water was generally condemned at the time, there is little doubt that flies played a considerable part in disabling more British soldiers than the bullets of the enemy, and that these insects must be held responsible for some of the millions of pound sterling which that war cost. It is a wonderful thing that a tiny, puny-looking insect should have been the means of prolonging war, and of the expenditure of some of the resources of the greatest empire of the world.

\* Reproduced from the Journal of the Royal Society of Arts.



The part played by house-flies in the transmission of typhoid fever was proved by a simple experiment. Col. Firth and Major Horrocks, of our Royal Army Medical Corps, kept flies in a large box fitted with a glass side. Some living typhoid bacilli growing on a jelly were left exposed in it; and the germs were found on the legs, wings, and bodies of the flies. In America typhoid germs were actually found on five flies caught in a room occupied by typhoid cases. And Ficker in 1903 kept flies in flasks, into which he had put some strips of blotting paper infected with typhoid germs. After twenty-four hours the flies were moved into clean flasks, and again moved every two or three days. At last they were killed with ether vapor and their remains transferred to gelatine, on which the typhoid bacilli were found growing twenty-three days after the flies had been exposed to infection. This evidence is regarded as conclusive by the most authorities.

Recent research has shown that house-flies may convey several other diseases—ophthalmia, cholera and tuberculosis, swine fever, possibly diphtheria and small-pox. But there is one other most important disease which there can be but little doubt is carried by house-flies. It is infantile enteritis, or summer sickness of children.

It will be remembered how in London during the warm summer of 1911 this affection caused a great deal of trouble. Special dispensaries were opened and salt-water cures advertised, while hospitals were soon filled with sick and dying infants. This disease kills thousands of children in the world every year, and is the cause of a considerable infant mortality. It is a disease of babies. They are attacked suddenly, and many of them succumb after a few days' illness, sometimes after a few hours. In London during the year 1910 there died of this disease 1,811 infants under two years of age; and during the warm 1911 the death rate grew to even greater proportions. In Bombay during 1910, 2,263 perished; and in Paris the disease killed 1,152 infants; in New York, 5,649; Chicago, 3,384; Rio, 2,082. Here, then, is a formidable disease, and it is in our midst.

During the years 1905 to 1908 a series of researches were carried out by Dr. Morgan at the Lister Institute of Preventive Medicine in London. He examined 469 children suffering from infantile enteritis in the wards and out-patient departments of the various London children's hospitals. As a result, he discovered a bacillus, which he named "Morgan 1," and this he found predominating conspicuously over all the other germs in the disease. Young rats and rabbits were fed on the bacillus, and they died of acute enteritis. Then four monkeys were given the germ in their food, and they died with symptoms exactly like those of the children in the hospitals.

The question of the transmission of this bacillus from one child to another was next considered by Morgan and Ledingham. A number of flies caught in houses in which there had been children sick with this infantile enteritis were examined, and the same germ found in them. They were killed with ether vapor and their bodies examined, and the germs found in and on the flies caught. Thus house-flies are convicted of being directly concerned in the transmission and spread of the disease.

This discovery has thrown a new light on the important question of child life. Thus at Cairo during the spring of 1900, when I was health officer of that city, there was an interesting repetition of some of the plagues of Egypt, as described in the Bible. February and March that year had been unusually cold for Egypt, but on April 24th heavy rains occurred—an uncommon event in that generally rainless climate. The summer was ushered in by a heat-wave on May 1st, and the temperature rose to 102 deg. Fahr. in the shade. Fourteen days later a plague of flies appeared in the city, owing to the quantities of damp, rain-sodden manure that the streets, stables and Eastern court yards contain, for, as will be shown presently, flies breed in manure; and Cairo is a filthy town, being in a most insanitary condition. The flies bred in myriads, and the houses were soon swarming with the pests. Everybody complained, Europeans and natives alike. Food was made black with the insects, milk was contaminated, and fruit was marked and rendered bad by multitudes of flies. Never before had there been such a plague of flies seen by living people, not even in South Africa during the Boer war. Then began the illness and death of the newly-born, not only the first-born as in the Biblical story. On all sides were the cries of Rachel weeping for her innocents. The general death-rate rose. During one week in May it reached the truly terrible maximum of 105 per 1,000. The infant mortality passed all bounds, and in two months 3,000 children under five years had succumbed to enteritis.

No doubt the flies conveyed the germs of this disease from one child to the food of others, and these, once infected, died within a few hours. The hospitals, the

dispensaries, and the Lady Cromer charities were worked at full pressure, but still the infants died. Had there been an anti-fly campaign at Cairo as there is an anti-mosquito campaign at Ismailia, many of these valuable lives—and children's lives are most valuable to the community—would have been saved. Had the street and stable manure been removed and destroyed regularly, the fly-plague would not have occurred, and many of these children would be alive to-day. In London during the hot summer of 1911 a similar thing occurred. During the week ending July 29th the infant mortality rose from 173 to 303, and later to 636 per 1,000 born. There was a great increase of house-flies in the slums, and this was the result.

The question is, how can we be rid of flies? It is obvious that we must apply, if possible, the methods employed on the Suez Canal, the Panama Canal, etc., for the expulsion of mosquitoes. For flies resemble mosquitoes in their capability of transmitting human diseases; and if we can succeed in reducing their numbers, the maladies they convey will also be reduced.

But before suggesting measures for eliminating the numbers of these insects, it is essential that some of their habits and their mode of propagation and breeding should be understood.

John Ruskin described the fly as "the queen of the air." Had he realized her life and the work she does he probably would have altered his opinion of her. The house-fly is more aptly described as the queen of everything and anything unclean. In the first warm days of spring, when the birds have begun nesting and the wild drake has donned his plumage, the sleeping fly-queen wakes from her long winter lethargy. She has mated on one of the last days of summer with a male of her kind, and now she has many eggs to lay. She leaves her winter place, which is some warm, dirty nook in some warm, dirty corner, and away she goes to lay those eggs. Nature having endowed her with a strong maternal instinct, she naturally chooses that sort of place where she herself was born, and where she knows her young, when hatched, will not want for food or warmth and will thrive. She herself was born in a manure heap, and there she will lay if she can. But any collection of refuse, garbage, offal, or abomination will suit her purposes as well. Each female fly lays about 120 eggs at a sitting—there are frequent sittings when the weather is warm; and the eggs are laid in batches, little clumps of small white oval objects, in and around any putrid, fermenting, or rotting thing.

In a few hours, if the surroundings are warm, each one cracks and gives birth to a tiny white crawling maggot or grub, like a silkworm caterpillar. Each maggot eats the filth it lives in, and as it eats it grows and molts, leaving pale transparent skins to tell its tale of life behind it. These empty bags of skin help us to recognize fly-breeding places, and enable us to find and deal with them. At the end of five summer days from the time of the hatching of the egg, the maggot becomes a chrysalis—a minute, rolled up, bean-like body, less than a quarter of an inch in length, white at first, then brown, lying motionless among the straws of horses' bedding, or appearing in small but numerous clusters at the corners of a manure heap, or at the edge of a dust-bin, or around a refuse-tub. Within this bean-shaped body the fly we know so well is made.

For within this cocoon or chrysalis the maturing maggot has withdrawn itself into a tiny oval living thing; and it develops six legs, two wings, a head and a neck, eyes, and a snout or protrudable proboscis, all packed within the cocoon case, but sheathed by a protecting membrane like mummy-cloths. This chrysalis stage lasts for another five days, while the embryo fly takes no food and has no encounter with the outside world. If the weather is cold, this stage may be prolonged even for two, three or four weeks. So that the life of the house-fly and the numbers born depend on the climatic conditions. But after five days, if the weather is favorable, the cocoon case splits, and the fully formed fly emerges, pushing itself out from within. First the head, then the antennae, proboscis, and eyes, are protruded, and the forelegs are thrust out; and slowly the flying insect is born—like the delivery of a new aeroplane from its hangar—to live its life of freedom in the air. The full-grown fly leaves its old home—the cocoon case with its mummy-cloths—to take care of itself, and it pushes, walks and crawls away from its former surroundings in the dung heap or dust-bin. Arrived at the edge of its nursery, it tries its wings, cleans its legs by rubbing them together, and sets out in search of food and adventure.

The house-fly is a strong, stout, bristly, hairy, two-winged, six-legged flying insect. Some are larger than others—this is a family matter; but the females are generally larger than the males, and some are more gaily dressed than the others. They have hereditary characteristics, as we have. So far as the diseases they convey are concerned their mouths and legs are the most important parts. The fly does not bite or suck

blood like the female mosquito, but she carries the disease germs on her legs, which are bristly and strong; each has two claws, and a sticky pad with which to hold on to seemingly impossible slippery surfaces. The whole body, as well as the legs, is covered with hairs. The mouth consists of a proboscis which ends in flabby lips that can be protruded and applied to the food. There are no teeth, but each lip has some hard ridges which can be used as rasps or saws for mastication. There is a copious saliva. The lips are applied to the lump of sugar, the saliva forms a paste, this is swallowed, and the fly moves on to the next spot and repeats the process. Some of the paste adheres to the lips and proboscis, and the fly uses her front legs to clean her face, her hind legs to clean the front ones. In consequence, her legs become covered with her food, and with any germs it may contain; and her mouth, her legs, her body, are all besmirched with them. But she likes to live in the midst of plenty, and the more filthy food she has sticking to her mouth and legs the more she enjoys it. The germs like it, too, for the fly never has a bath. It is a grand, dirty life.

It can be readily understood how disease germs live and multiply on these sticky surfaces, entangled with the fly's food, on its legs, among the hairs and bristles, as well as on the lips and proboscis. Germs are also swallowed and multiply within the insects, and then are found again in the fly-specks which are so common on the window pane or in the milk jug, or on the bread. Thus do flies transmit disease.

We can prevent them; we can reduce their numbers easily. But it is of little use trying to catch or trap the insects; we cannot hope to reduce their numbers like that, as was found at Port Said, where a fly-catching campaign was tried. The flies must be prevented from coming to maturity by the destruction of the maggots and eggs and cocoons. It has been estimated that one female can produce 506,250,000 offspring in one month. If we clean out the manure heaps where these offspring are we shall have so many flies the less. Whereas if we wait and then try to catch or trap the grown insects we shall be lucky if we succeed in destroying more than a thousand or so at most—the flying insects scatter at once. This is the reasoning on which fly reduction rests. We must remember that only one fly in every million, perhaps, becomes infected with disease germs. We cannot expect to catch and kill it. We must try to prevent that one from being born into the air, and the best way to do this is to reduce the total numbers born.

Fortunately, flies remain in the maggot stage for at least a week; therefore we need only deal with the breeding places once a week, but this must be done regularly and perseveringly throughout the whole of the fly-breeding season. All manure heaps, stables, slaughter houses, garbage, refuse depots, collections of waste food, dust-bins, ash-boxes, swill cans, middens, and all the filthy places which are near dwelling houses must be made clean once a week.

It is true that this is the work of the sanitary authority. But sanitary authorities will operate better, will initiate new public health measures with zeal and enthusiasm, if there is the sympathy and co-operation of the public with them. We must talk and agitate. We must ask them about flies again and again; we must implore, if necessary. Soon the object will be attained; flies will be reduced; and then we shall have little summer sickness, and the infants will live instead of dying. Everybody can help.

Let the dictum go out that the presence of house-flies in a house is a sign of insanitation, and their numbers a measure of that insanitation. In the towns of the Suez and Panama Canals mosquito-breeding places are all dealt with regularly once a week by organized gangs of sanitary inspectors, known as "mosquito brigades." House-fly breeding-places are as easy to deal with as those of the fever-carrying mosquitoes. Why cannot we have "fly brigades" here at home? Let us deal with all fly-lairs regularly once a week. Flies carry disease; therefore let us prevent them.

In conclusion, the details of an interesting experiment in fly-reduction which has been recently conducted in New York may well be described. In the Borough of The Bronx of that city a district containing 1,725 individuals and 362 children under five years of age has been protected against flies by an organized campaign in which even the Boy Scouts were employed to deal with the insects of the courtyards, waste spaces, and stables. Another similar area was allowed to pursue its usual fly-plagued course. As a result, there were only 110 cases of infant sickness recorded in the protected area, while among the "outside" families there was a total of 165 cases.

Although these figures are too small to enable us to draw exact conclusions of disease-reduction, they are sufficient to show that fly-reduction is a most promising sanitary measure, and as such worthy of the notice of our sanitary authorities.



Fig. 1.—Waves striking Bilbao breakwater.

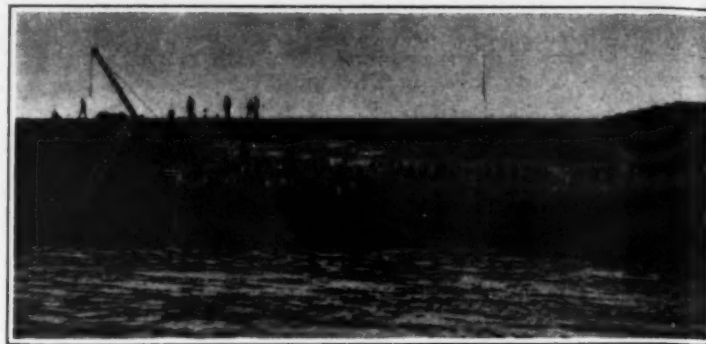


Fig. 2.—Repaired break of Wick pier. Rough stones sticking out of concrete.

## Wave-Action on Harbor Breakwaters and Piers\*

Blocks Weighing Over Two Thousand Tons Displaced Many Feet by the Force of Waves

By E. R. Matthews, Assoc. M. Inst. C.E., F.R.S.E., F.R.G.S., F.G.S.

THE collapse of a breakwater due to wave-action can usually be attributed to the settlement or giving way of the foundations of the structure, or the loosening or extracting of some of the face-blocks. Storm-waves have a considerable drawing force. Huge stones, weighing in some cases many tons, are sometimes extracted from a breakwater by the force of the waves. At Ymulden, for instance, a header-block in the pier, weighing 7 tons and "measuring 7 ft. in length, and presenting a face to the waves of 4 ft. by 3 ft. 6 in., was started forward to the extent of 3 feet by the stroke of a wave compressing the air behind it." The top of this block was level with low-water of ordinary spring tides.

As to the point where the maximum intensity of force of a wave occurs when the wave strikes, say, an upright surface, a good deal of discussion has from time to time taken place, but the experiments carried out by Lieut. Gaillard, of the Corps of Engineers, United States Army, are enlightening. He came to the conclusion that the maximum intensity of the striking force occurred at a level slightly above still water, and that the force of the wave diminished at the crest to zero, and to one half the maximum at the bottom. Though this conclusion may not be accepted as final, it may be taken as approximately correct.

The greatest velocity is found in the case of long waves in deep water, regardless of their height. Tidal waves in the open sea proceed with a greater velocity than when they approach near the shore. The maximum velocity attained by a shore-wave occurs when an on-shore gale is blowing at exceptionally high spring tides. The velocity of the large tidal waves of the ocean is accelerated by the wind force behind; and although their progress is retarded by the shallow water into which they run, they nevertheless break with tremendous force upon any obstruction which they may meet.

It is not proposed in this article to deal with earthquake waves, except to say that these often attain great proportions and extraordinary velocity. For example, "In 1854, the waves caused by the earthquake of Simoda, in Japan, had lengths of from 221 to 256 miles, crest to crest, and velocities varying from 427 to 438 miles per hour." In dealing with the velocity of the waves likely to strike a breakwater or harbor pier, it may be assumed that these are always of much greater length than the depth of water. If this be so, their velocity depends only on the depth, and is proportional to the square root of that depth.

Sir G. B. Airy in his "Tides and Waves," says: "It is, in fact, the same as the velocity which a free body would acquire by falling from rest, under the action of gravity, through a height equal to half the depth of the water." The well-known formula for accelerated motion may therefore be used in this connection—namely:

$$V = \sqrt{2gS}$$

where

$V$  = Velocity of wave in feet per second.

$g$  = The velocity attained by a falling body at the end of the first second = 32.17 feet per second.

$S$  = Space fallen through in feet, in this case half the depth of the water.

This principle does not apply to "ground swells" or "rollers," which are often many miles in length, and which cause erosion of the sea-bed in great depths of water. Such waves as these are generated at some

distant part of the sea, and they often travel at a greater rate than the gale which generated them.

The pressure on the face of a breakwater due to the striking of the wave rises approximately to  $V^2/2g$  feet of water.<sup>2</sup>

Thos. Stevenson measured these pressures by means

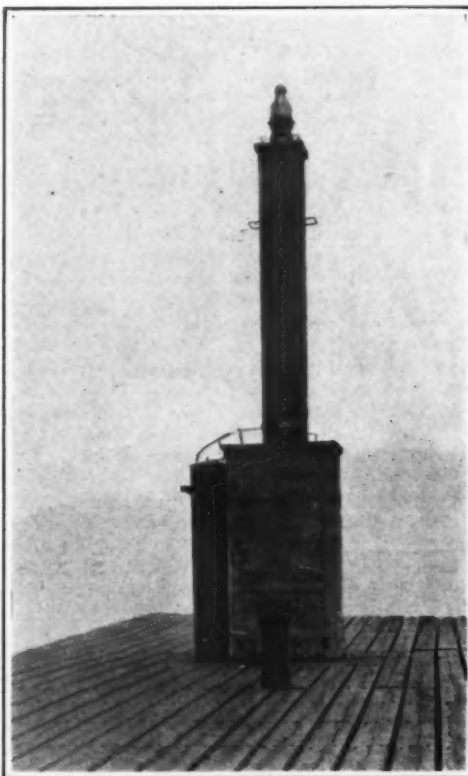


Fig. 3.—A close view of the Ludington south breakwater light as it appears in calm weather.

of a dynamometer, and found that "as great a pressure as  $3\frac{1}{2}$  tons per square foot was recorded at Dunbar, and 3 tons per square foot at the harbor works at Buckle, on the Banffshire coast."<sup>3</sup>

<sup>2</sup> Transactions of the Royal Society of Edinburgh, vol. xvi, page 23.

<sup>3</sup> "The Design and Construction of Harbors," by Thos. Stevenson (page 51).



Fig. 4.—How the spray rises above the Ludington breakwater light in a storm.

**Destructive Force of Storm-waves.**—The force exerted on the breakwater at Wick during the storms of 1872 and 1877 must have been tremendous, for an enormous block, "weighing no less than 2,600 tons, which, after remaining undisturbed for three years, was carried away bodily by the storm in 1877, and deposited in two pieces within the line of the breakwater." Mr. Shield, in his work on "Harbor Construction," states that the cliffs at Wick above sea-level are from 70 feet to 80 feet in height, and that storm-waves striking them frequently go over the top. On one occasion a block weighing 15 tons (see Fig. 5) was displaced by the sea. Fig. 5 is a rough sketch of the interesting illustration of this block, taken from page 79 of the book referred to.

The effects of waves on the breakwater at Bilbao (Bay of Biscay) are interesting. This breakwater is shown in plan in Fig. 6, and may be briefly described as follows: The original structure was a breakwater of the mixed type, with an inner core of small rubble and an outer core of large rubble, upon which large concrete blocks, each containing from 39 to 60 cubic yards and weighing over 60 tons, had been deposited at random, the superstructure being of mass concrete, with block facings. The structure was brought up to just above low water of ordinary spring tides, the foundations being for the most part mud and sand. In the storm of 1894 the huge blocks forming the protecting apron were carried away. This apron was 26 feet wide and 16 feet in depth. The foundations also gave way. A remarkable occurrence in connection with this storm was the removal of a monolithic mass weighing about 1,700 tons, and the carrying of this a distance of 105 feet. The terrific force with which waves strike the Bilbao breakwater may be imagined from the photograph (Fig. 1), which illustrates a large wave striking this structure during a storm occurring on November 22nd, 1912. In 1893, the work having been only partially carried out, an amended design was agreed upon, and this included the erection, outside the breakwater, of an apron consisting of concrete blocks, each containing from 40 to 65 cubic yards, and resting on a rubble base. This apron, which is about 100 feet wide, is carried up to about low water of spring tides, and is approximately 100 feet from the face of the wall, which is built on a rubble foundation.

In order to safeguard as far as possible against the displacement of blocks on the seaward face of a wall during a storm, it is very necessary that the joints above low water should be kept well pointed with cement, as unless this is done, a wave striking the outer face of the structure will compress the air in the open joints, and the outer blocks will be loosened. The air or water in the joint may thus become a very destructive agent.

On the sheltered face of the wall there should be numerous weep-holes to prevent the accumulation of water inside the structure, and to reduce the pressure occasioned by any water that may have been driven in on the seaward face of the wall, and to act as air-vents. This is a most important matter. Much damage to harbor piers would have been avoided had these precautions been taken in building the wall. In fact, it is well to leave open joints right through the structure below low water to prevent the pointing work above low water from blowing out.

In January, 1912, during a storm a serious breach occurred in the Wick Pier. The slope was built of flat

<sup>4</sup> "Dock Engineering," by Brysson Cunningham, B.E., Assoc. M. Inst. C.E.

\* Reproduced from *Engineering*.

<sup>1</sup> W. Shield, M. Inst. C.E., "Principles and Practice of Harbor Construction," page 83.

<sup>2</sup> "Physical Geography of the Sea," by Maury.



stones set on edge and dry jointed, the joints being pointed up with cement mortar. During the storm, first a few of the stones shifted at the toe of the wall, then some of the paving above high-water blew up, then the large breach, nearly 100 feet long and ex-

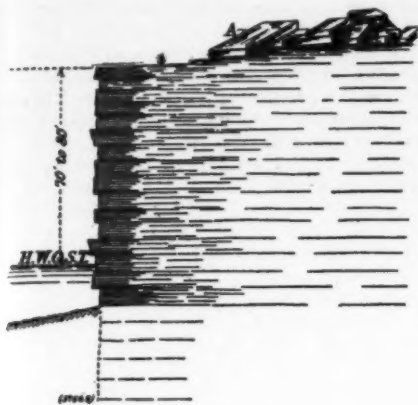


Fig. 5.—Cliffs at Wick.

tending almost through the pier, occurred, the part of the slope near the toe going last (see Fig. 10, which is a sketch of the cross-section). It took eight months to repair this damage, and cost about \$25,000, the weather being so bad that during that time operations in concrete work could only be carried out on one in every three days.

In repairing the breach, the engineer wisely made the experiment of studding the slope with heavy stones, half in and half out of the concrete, and this has acted extremely well in breaking up the seas (see Figs. 2 and 10). The result of this method of construction has been that only seldom do waves reach the parapet above the repaired breach, whereas on either side they run right up to the parapet. Then, with the object of reducing the scouring action at the toe of the structure, which was very great, the engineer decided to place four or five old herring-fishing boats, each about 50 feet long by 18 feet beam, at the toe of the pier. These boats were filled with as much concrete as they were able to support without sinking—about 50 tons. When the concrete had set they were towed out and sunk upright, and then filled with concrete under water, blocks of about 150 to 180 tons each being thus secured.

It is interesting to note that the last block was set, by accident, about 30 feet too far northward of the toe, but in a storm was bodily shifted back hard into the toe. Another incomplete block of about 50 tons was lifted up and carried 50 feet, and deposited on the top of another which was 6 feet or 7 feet higher. Mr. Goulcher states that when repairing the breach he took the

causing a shoal; by so doing oscillating waves are converted into breaking waves, often with serious results so far as the structure at the back is concerned. Natural obstructions of this kind may occasionally be met with, but artificial obstructions should not be formed.

There is a natural obstruction of this nature at Peterhead, for example, and an important lesson may be learned from it. Mr. W. Shield has described this in his work on "Harbor Constructions." He states that

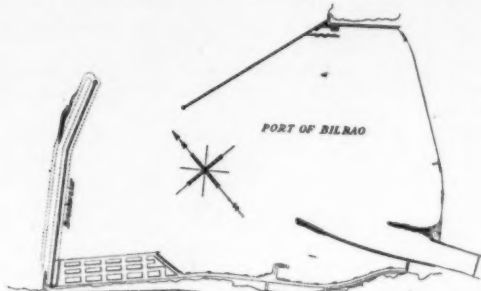


Fig. 6.—Plan of Bilbao harbor.

the quay-wall at Peterhead rests on a rock base about 2 feet above low water. This rock bed suddenly dips at a point a short distance seaward of the wall and the water increases to about 30 feet in depth. At a point 160 feet from the wall there is a ledge of rocks, on which the water shoals to 22 feet; it then suddenly deepens to over 50 feet. When the tide reaches 7 feet or 8 feet up the wall there is no wave-stroke, but the

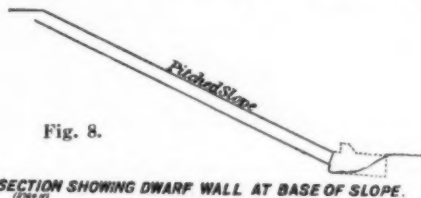


Fig. 8.

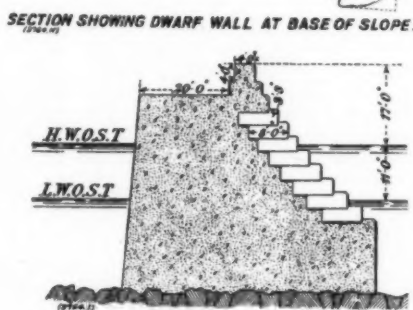


Fig. 9.—Step-faced concrete wall.

been occasioned by the obstruction so formed, which, instead of being a great advantage to the harbor, has proved to be a serious disadvantage.

The matter stands thus: Until a wave breaks it does practically no damage; it does not usually break until it reaches shallow water; therefore, to put down an obstruction which will cause the oscillating wave suddenly to turn into a breaking wave means that the wave, which, up to that time, has been traveling toward the breakwater in deep water, and at a much greater veloc-

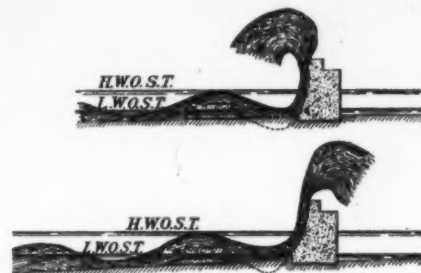


Fig. 7.—Effect of obstruction in path of wave.

ity than it would attain in shallow water, strikes the obstruction creating the shoal and is flung forward with tremendous velocity against the breakwater or pier. Not only so, but as the seaward face of such an obstruction usually slopes down toward the sea-bed, this inclined plane assists the approaching wave very considerably, for the wave, approaching at considerable velocity, runs up this incline and shoots forward in the direction of the upper part of the harbor wall, striking the latter with great force, and often displacing blocks in the wall (see Fig. 7).

**Stepped-faced Breakwaters.**—It is quite impossible to name one type of breakwater as an ideal to be always followed, as every case must be considered on its merits. Generally speaking, however, the upright wall type is not to be favored, whether the seaward face of the wall be vertical, battered, or curved. A stepped-face structure, similar to that erected at Sandy Bay, U. S. A., has many advantages. Fig. 11 illustrates the section of breakwater of this type. It consists of a rubble base surmounted by a masonry structure. The breakwater is faced with concrete blocks (Fig. 11, detail), which, on the seaward face, are each 12 feet long by 3 feet in thickness by 6 feet in width. Each block is notched into the one below it, to prevent sliding or extraction by a wave, and the exposed edge is chamfered 3 inches. The foundation blocks are 15 feet long by 4 feet minimum thickness by 6 feet in width. On the inside face of the breakwater the blocks are 8 feet long by 3 feet deep by 4 feet wide, and are notched into one another in a similar manner. The foundation

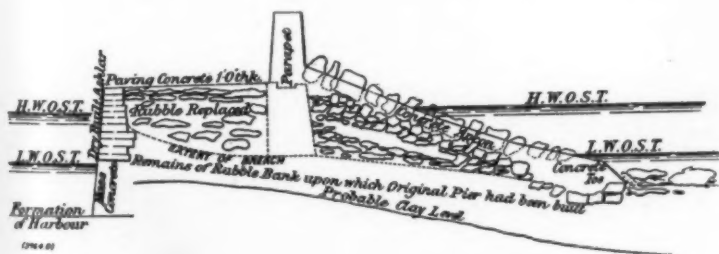


Fig. 10.—Cross-section of breach repaired in Wick pier.

precaution of putting in air-vents running from the underside of the concrete-paved slope, through the parapet to the roadway side. He also provided eight 15-inch square holes, and during heavy weather air escapes through these with appreciable velocity.

It is a very great mistake to put obstructions of considerable magnitude outside a harbor wall or breakwater, and running parallel with it, with a view to

undulations rise and fall against the wall. When, however, the water becomes more shallow, the waves strike the reef, and the breaking wave proceeds forward until it strikes the quay-wall, often with such force that it is flung upward to a height of 100 feet.

To invite a difficulty of this kind by forming such an obstruction is a serious matter. One or two instances could be cited where tremendous damage has

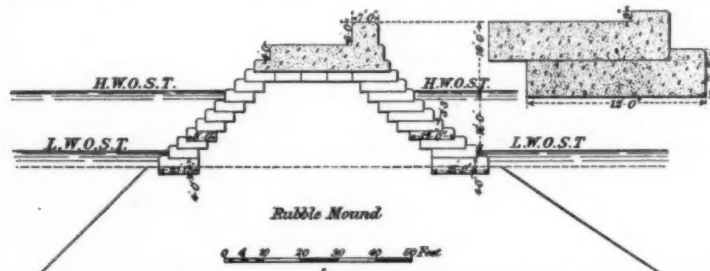


Fig. 11.—Section of step-faced breakwater.

blocks of the inside face are 10 feet by 4 feet minimum thickness by 4 feet wide. The upper portion of the structure is of concrete *en masse*, forming one monolithic construction which it would be impossible for the sea to displace. The advantages of this construction are that the wave as it strikes it is broken up by the stepped face, and the scour at the base of the structure is considerably reduced by the projecting steps

Fig. 12. PLAN OF WALL WITH CONCAVE CURVE

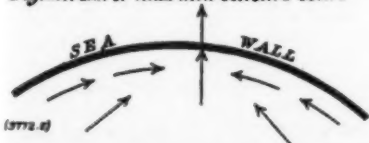


Fig. 15. WAVE STROKE ON CURVED-FACED WALL.



Fig. 13. WAVE STROKE ON VERTICAL WALL.



Fig. 16. WAVE STROKE ON CURVED WALL AFTER PROFILE WAS AMENDED.



Fig. 14. VERTICAL WALL WITH PROJECTING CORNICE.

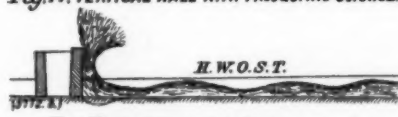


Fig. 17. SLOPING FACE WALL.



forming the face of the wall. It is really astonishing what a tremendous scour is produced by a wave at the foot of a smooth-faced slope; even in calm weather this may be observed, and occasionally it is found necessary to protect the base of the slope strongly in order to modify the scour. At Wick, Mr. Goulicher built a mass-concrete dwarf wall at the bottom of the slope (see Fig. 8), and this has considerably lessened the scour; the water falls over it without force. With a stepped-faced wall the scour is largely obliterated.

Where there is a good foundation and fairly shallow water, and the mound type of breakwater is not necessary, but a wall is to be built, the design shown in Fig. 9 is recommended as suitable. This type of wall will prove most efficient in breaking the force of the waves and less expensive in upkeep than the smooth-faced upright wall. The wall shown in Fig. 9 is a mass-concrete wall, built in temporary wooden frames on a good, rocky bed, and stepped on the seaward side, having a smooth battered face on the inside.

No blocks weighing less than 6 tons should be used in the work, and the size of blocks recommended is as follows: Length, 8 feet; maximum depth, 3 feet 3 inches; minimum, 2 feet 6 inches; width, 5 feet. The concrete of which the blocks are made should be in the proportion of 6 to 1, except the exposed face, which should be 4 to 1, and faced with granite spalls, or, preferably, basalt, and the mass concrete should be 8 to 1, with a 6 to 1 facing mixture for a depth of 1 foot. All blocks should be laid as headers, and it is very necessary that each block should have a roughened surface in order that a more secure cement joint may be made.

**Height of Waves Governed by Depth of Water.**—The author's observations support the theory laid down by Mr. Scott Russell, and arrived at by him after valuable experiments, that a wave is seldom, if ever, higher than the depth of water. Mr. Scott Russell said he had "never noticed a wave so much as 10 feet high in 10 feet of water, nor so much as 20 feet high in 20 feet of water, nor 30 feet high in 30 fathoms of water, but he had seen waves approach very nearly to these limits." Assuming the datum referred to is the mean level of the sea, this statement may be taken as accurate. The mean water level one would suppose to be situated halfway between the crest and trough of a wave; but this is not so. Prof. Rankine has shown that the mean level of the sea may be arrived at by the following formula:

Let  $L$  be the length of a wave,

$H$  the height of wave (trough to crest).

Then the diameter of rolling circle

$$= \frac{L}{3.1416}$$

Radius of orbit of particle

$$= \frac{H}{2}$$

Elevation of middle level of wave above still water

$$= \frac{3.1416 H^2}{4 L}$$

$$= 0.7854 \frac{H^2}{L}$$

Consequently, crest above mean water level of sea

$$= \frac{H}{2} + 0.7854 \frac{H^2}{L}$$

Trough below mean level

$$= \frac{H}{2} - 0.7854 \frac{H^2}{L}$$

On many occasions the author has seen waves which rise to a greater height than the depth of water, but these have always been caused by the backwash of a wave returning after it had struck the breakwater or sea-wall, and meeting the oncoming wave. A wave breaking upon a shore, unobstructed by any structure, may always be taken as being of no greater height than the depth of water through which it is traveling. It must not, however, be assumed that the highest waves are the most destructive.

**Varying Conditions Affecting Breakwater Design.**

(a) **Natural Shoals.**—If for some distance seaward of a harbor there is shallow water, the bed of the ocean being fairly flat, but outside this extensive shallow area the sea-bed suddenly dips and there is very deep water, the height of the waves likely to strike the breakwater will not then be governed by the depth of the sea outside the shallow area, but by the average depth of the shoal water. It must be remembered, however, that the smaller waves may do quite as much damage to the structure as the larger ones. A great deal of damage is done, in some instances, to coast protection works when the waves have not been nearly so large as at other times.

(b) **Artificial Shoals.**—Artificial shoals, while advocated by some marine engineers, are not to be recommended for reasons given above.

(c) **Deep Water Near Shore, Shallow Outside.**—A case may arise where a harbor has to be constructed in a position where there is deep water near the shore and an extensive area of shallow water outside, caused either by the sea-bed being elevated some distance from the land, or by the formation of huge sand-banks several square miles in area. In a case of this kind, waves of great height cannot be generated owing to the shoal referred to, but the ocean waves running into the shallow water are broken up into smaller waves, which pass over the obstruction and travel onward toward the shore. In designing harbor works under these conditions, the depth of water near the shore will not affect to any great extent the size of the waves likely to strike the structure, and should therefore not be seriously considered.

(d) **Breakwater Construction in Deep Water.**—In many cases the breakwater has to be constructed in deep water, which rapidly becomes deeper in the seaward direction. Wave-action under these conditions is most severe, and in designing the breakwater the height of the waves for, say, half a mile seaward, must be carefully considered.

The author is indebted to the chief engineer of the Bilbao Harbor, V. Gorbefia, and to Mr. G. E. B. Goulicher, resident engineer on the harbor extension works at Buckle, Banffshire, and formerly on the Wick Harbor Works, for much useful information regarding the destructive action of the sea on the works of which they have or have had charge.

#### EXPERIMENTS WITH MODELS.

In order fully to satisfy himself regarding wave-action on breakwaters of various profile, the author decided to carry out a number of experiments by means of models. The apparatus used was very simple, and consisted of shallow enameled trays specially adapted for the purpose; the breakwaters were made in plasticine, and were to scale, as was also the depth of water in the tray. Wave-action was easily produced in the trays, and the results in every way verified the opinions expressed above.

Another point of considerable interest was also demonstrated, and that was, the folly of building sea-walls curved in plan (concave curve), as shown in the diagram (Fig. 12). The result of doing this is that the wave striking the sea-wall runs along it, as shown by the arrows in the diagram, and when the two portions of the wave meet, the sea shoots upward and falls usually at the back of the structure, sometimes doing considerable damage. The shape of the wall itself is of little help in a case of this kind. Even with a stepped-face wall the same thing occurred, but with slightly less serious effect.

**Wave-stroke on Vertical Wall.**—The first type of wall experimented on was the "vertical" wall. It was found that, when a wave struck this, if there were no provision for throwing back the wave, the latter shot upward to a considerable height, and if uninfluenced by the wind, about half of the wave fell at the back of the wall, and the other half at its base, causing much scour. This is illustrated in Fig. 13. The dotted lines indicate where the scour is produced.

**Vertical Wall with Heavy Projecting Cornice.**—A projecting cornice was then added to this vertical wall. The result of the wave-stroke on the wall then is shown in Fig. 14. No portion of the wave went over the wall, but the whole of it fell back at the base of the wall, causing in actual practice considerable scour.

**Curved-face Wall.**—The action of the wave in this case is very apparent, and is seen in Fig. 15. This profile assists the wave in leaping over the wall, and is a profile which is not to be recommended.

**Curved-face Wall with Projecting Cornice.**—A wall of this type may be considerably improved by the construction of a heavy projecting cornice. Fig. 16 illustrates this, and shows how much better a wave is thrown back by the addition of such a cornice.

**Battered-face Wall.**—A sloping-face wall, without any provision for throwing back the wave, is almost as bad as a curved-face wall, as the batter encourages the wave to ascend instead of retarding its progress, as in the case of a stepped-face wall. The experiments demonstrated the fact that a wave striking a battered face wall will leap over the wall, as shown in Fig. 17.

## The Marble Light\*

Agreeable Effect on the Eyes Due to Elimination of Infra-Red Heat Rays

By W. Voegel

ALTHOUGH "marble light" is a very misleading name for a light inclosed in translucent plates of marble, it is here retained because it was chosen by the inventor of the device, is short, and is already in common use.

It has long been known that marble in thin plates is translucent, and that beautiful effects can be obtained with colored marbles. Pfaff produced marble plates from 1/25 to 1/50 inch thick, of dimensions up to 36 by 20 inches, which were strengthened by inclosing them between plates of glass; and mosaic pictures and windows, far surpassing in brilliancy those composed of tinted glass, have been built up of thin bits of colored marble. The great cost of producing thin plates prohibited the employment of marble in lamp casings until W. Engel of Hamburg succeeded in producing marble plates 1/8 inch to 4/5 inch thick, which are more translucent than ordinary milk glass. The plates are polished on both faces and are impregnated with various oils at high pressures and temperatures.

I have tested Engel's plates in regard to their translucency for visible, ultra-violet, and infra-red rays, and compared their diffusing power with that of milk

glass. I have also substituted marble for milk glass in the same lamp, and proved the superiority of the marble by photometric measurements.

A. TRANSLUCENCY AND DIFFUSIVE POWER OF MARBLE FOR THE VISIBLE SPECTRUM.

Two marble plates 0.14 inch thick, with polished fronts and ground backs, were compared with a milk glass plate 0.07 inch thick, with both faces ground (designated as "light milk glass") a denser milk glass plate 0.12 inch thick with both faces polished ("dark milk glass"), and a plate of ordinary ground glass 0.12 inch thick. The filament of an electric lamp could be distinguished through the ground glass, but not through the milk glass or the marble.

For the same distance between the photometer and the source of light (a Nernst or metallic filament lamp) the illumination, taken as 100 when no plate was interposed, was diminished to 23.2 by the marble, 19.1 by the light milk glass, 14.1 by the dark milk glass, and 67.4 by the ground glass. Another series of experiments, in which the light transmitted by the marble was taken as 100, gave mean values of 81 for light milk glass, 56 for dark milk glass, and 300 for ground glass.

The treated marble, therefore, is far more translucent than either plate or milk glass.

Furthermore, it is illuminated uniformly to the edge and appears pure white in comparison with the milk glass. When viewed by transmitted light the marble appears reddish-violet, and the milk glass assumes a dirty greenish hue. Tested in different parts of the spectrum the translucency of the marble was found to be 111 in the red, 100 in the yellow-green, and 141 in the blue, taking the transparency of the light milk glass as 100 in each case. The treated marble, therefore, transmits more red and much more blue than the milk glass, as its reddish violet appearance by transmitted light indicates.

The treated marble is particularly efficient when it is applied to the mouth of a conical reflector containing an ordinary incandescent lamp, in which case it cuts off only one fifth, while milk glass cuts off two fifths, of the light.

In order to determine whether the greater translucency of marble is accompanied by a loss in diffusive power, as is the case with ground glass, an aperture in an opaque screen placed before a Nernst lamp was covered successively with marble and various glasses, and the light transmitted in different directions was measured. The dotted lines in Fig. 1 represent the diffusion curves for marble, and light and dark milk glass. The amount of light emitted in any direction

\* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *Elektrotechnische Zeitschrift*.



is proportional to the length of the numbered straight line intercepted by the curve. Each curve is accompanied by the corresponding circle of theoretical diffusion, according to the cosine law, with no loss of light. The close approximation of each curve to its circle shows that the treated marble, like the milk

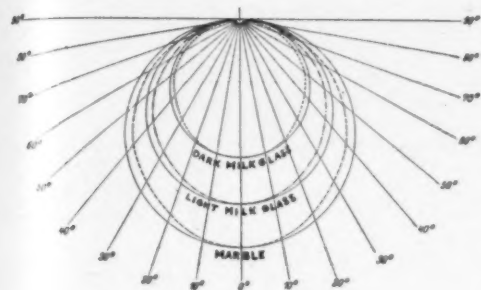


Fig. 1.—Diffusion curves.

glass, is a good diffusing agent. The curve for ground glass is a long narrow oval, and little light is diffused more than 20 degrees from the normal.

The translucency was measured by a photometer placed 8 feet in front of a 16- by 16-inch plate, illuminated by an electric bulb placed 4 inches behind it. Thus, it was found that the marble plate transmitted nearly 40 per cent, while a plate of milk glass transmitted only 17 per cent of the incident light.

In order to make a practical test of the marble light I hung in my laboratory a frame of the form and dimensions indicated in Fig. 2, in which plates of marble or glass could be inserted. In the interior was placed an osram lamp of 400 candle-power. The open top of the frame was about 3 feet from the ceiling, which is about 13 feet high. The room, 18 by 23 feet in area, is usually lighted by a suspended group of three 25 candle-power tantalum lamps with clear glass bulbs and by six similar lamps with ground glass bulbs, attached to wall brackets. The ceiling and walls were grayish-white. The illumination at fifteen uniformly distributed points, 4 feet above the floor, was measured with a Schmidt-Haensch universal photometer.

The nine scattered 25 candle-power tantalum lamps, consuming 386 watts in all, produced an average illumination of 25.6 lux (maximum 70, minimum 6), and consumed 0.43 watt per square meter-lux.

If nine tungsten lamps were substituted for the tantalum lamps the consumption of energy would be reduced to 0.31 watt per square meter-lux.

One 400 candle-power, 330-watt osram lamp inclosed in milk glass produced an average illumination of 20 lux (maximum 36, minimum 10), and consumed 0.43 watt per square meter-lux.

One 400 candle-power, 330-watt osram lamp inclosed in marble produced an average illumination of 27.7 lux (maximum 55, minimum 11), and consumed 0.34 watt per square meter-lux. It appears, therefore, that the single powerful marble light is approximately equal to nine scattered tungsten lamps in economy, and far superior to them in uniformity of illumination. The single light inclosed in milk glass also gives a fairly uniform illumination, but it is far less economical than the marble light, i. e., it produces a much lower average illumination for an equal consumption of energy. This difference would have been much greater but for the equalizing effect of the light, which in both cases escaped from the open top of the lamp and was reflected by the ceiling.

Every person whose opinion was asked pronounced the marble light peculiarly agreeable to the eyes. The explanation of this fact is not obvious, for the blinding effect of a naked light is prevented by thick milk glass as well as by marble. In order to find the explanation, I extended my experiments to the invisible parts of the spectrum.

#### B. TRANSLUCENCY OF MARBLE FOR ULTRA-VIOLET RAYS.

The radiation from a quartz mercury vapor lamp, filtered through dark blue Uviol glass and copper sulphate solution, which quenched all visible rays, was allowed to fall on an Elster and Geitel potassium amalgam photo-electric cell, connected with a galvanometer. When the plates of treated marble and light and dark milk glass were interposed successively in the path of the rays the deflections of the galvanometer were proportional to the numbers 100, 70, and 53. As the translucency of the three plates for visible rays was proportional to 100, 81, and 56, as I have stated above, the difference in the relative translucency for visible and ultra-violet rays is evidently too small to explain the agreeable effect of the marble light.

#### C. TRANSLUCENCY OF MARBLE FOR INFRA-RED RAYS.

The radiation from an electric bulb was allowed to fall on a vacuum thermo-element, connected with a galvanometer. When plates of marble and light and

dark milk glass were successively interposed the deflections were proportional to 100, 650, and 360. Hence, though milk glass is less translucent than treated marble for visible rays, it is from  $3\frac{1}{2}$  to  $6\frac{1}{2}$  more translucent for the total radiation of a carbon filament lamp. As the visible rays form a very small part of the total radiation, it follows that the marble must be very opaque to the invisible infra-red rays, which are not present in diffused daylight, and which are useless for vision and probably injurious. The fact that the eyes soon become fatigued when they are employed in reading or writing by lamplight has recently been ascribed to the retardation of the flow of retinal pigment by red, yellow, and infra-red rays, and Dr. Vogt has proved that the infra-red rays are not, as was formerly assumed, absorbed by the cornea, crystalline lens and other media of the eye. Only very long waves, like those emitted by a red-hot body, are thus absorbed, while the shorter waves emitted by bodies at white heat are transmitted with little loss to the retina. Vogt found that four fifths of the radiation that reaches the retina from a carbon filament lamp consists of infra-red rays. I have recently proved that nearly all artificial sources of light are richer than daylight in infra-red rays. Oculists have not yet proved conclusively that infra-red rays actually cause injury or fatigue, but this proof appears to be supplied by the universal testimony that the marble light, which is nearly free from these rays, is especially agreeable to the eye.

The practical conclusion follows that wherever indirect illumination is not practicable all lights should be masked by media that absorb infra-red rays.

In my opinion, marble treated by Engel's process is the best of all known substances for this purpose. It is even superior to water. In a comparative test with the thermo-element the galvanometer deflections were 32 for a 0.12 inch plate of marble, 266 for a 0.4 inch stratum of water, and 103 for a 2.8-inch stratum of water. The following table shows the results of tests of various media with the photometer and the thermo-element. The source of light was a 32 candle-power

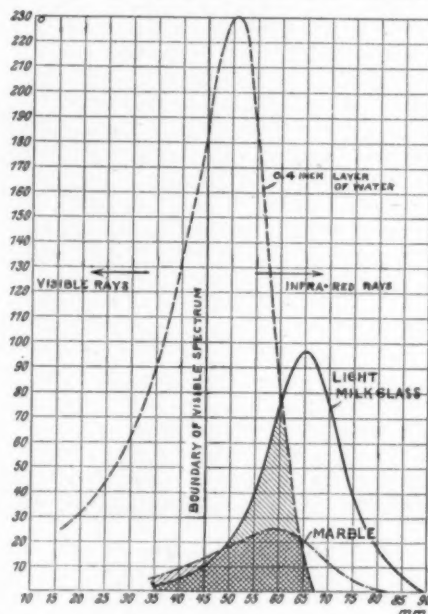


Fig. 3.—Distribution of energy in spectrum of transmitted radiation.

carbon filament lamp. (Incandescent gas light gave nearly the same results.)

#### TRANSLUCENCY AND DIATHERMANCY OF VARIOUS SUBSTANCES.

Thickness and Material of Interposed Stratum.	Illumination.	Percentage of Light Transmitted.	Deflection of Galvanometer.	Percentage of Heat Transmitted.	Heat Transmitted per Unit Illumination.
None.....	620	100	224	100	100
Treated Marble, 0.12 inch.....	225	41	11.5	5.1	12.4
Untreated Marble, 0.12 inch.....	130	21	11.0	4.9	23.3
Mica, 0.02 inch.....	200	33	151	67.5	208
Clear Glass, 0.08 inch.....	570	92	179	80	87
Hard Rubber, 0.01 inch.....	170	27.5	10.8	4.8	17.5
Writing Paper.....	340	55	37.5	16.7	30.4
Milk Glass, 0.12 inch.....	155	25	38.2	16.6	68
Ground Glass, 0.12 inch.....	470	76	91	40.6	53.4

The second column of figures is obtained by dividing the first by 620; the fourth by dividing the third by 224; the fifth by dividing the fourth by the second and multiplying by 100.

The figures in the last column show that mica is the least suitable of the substances (except hard rubber) and that marble treated by Engel's process is the best. Independently of the injurious effect of infra-

red rays on the eyes, the elimination of radiant heat is desirable, specially with gas and kerosene lamps. The reader's head can be brought, without discomfort, two or three times nearer the light when marble is substituted for milk glass. The marble plates, of course, should be so arranged that overheating will

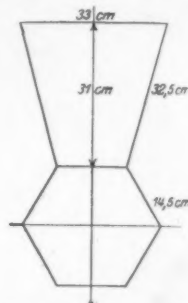


Fig. 2.—Experimental lamp casing. (1 centimeter equals 0.4-inch.)

be prevented by conduction to the surrounding air.

The distribution of energy in the radiation transmitted by the marble plate, the light milk glass plate, and 0.4 inch of pure water is shown graphically in Fig. 3. The curves were plotted from the indications of a Ruben thermo-element placed at various points of the spectrum, which was divided into millimeters. The source of radiation was a carbon filament lamp. The infra-red spectrum lies on the right, the visible spectrum on the left of scale division 45, division 30 falling in the yellow-red, 15 in the green, and 0 in the blue-violet. The galvanometer deflections are marked on the side of the diagram.

As we should expect, the marble curve is higher than the milk glass curve in the visible spectrum, but in the infra-red region it is very much lower, and its apex is nearer the visible red. The water curve was included because 0.4 inch of water, according to Dr. Vogt, is equivalent to the human eye in absorbing properties, so that the retina receives only those rays that are transmitted by a water stratum of that thickness. The proportions of such rays transmitted by milk glass and marble are indicated by the overlapping shaded areas in Fig. 3. It is evident at a glance that a much larger proportion of the infra-red radiation that can pass through the water stratum (or the media of the eye) is transmitted by milk glass than by marble. There is a still greater difference between the quantities of infra-red radiation transmitted by milk glass and marble, respectively, and absorbed by the media of the eye. These quantities are represented by the unshaded areas of the milk glass and marble curves to the right of the water curve. The following experiment seems to prove that this absorbed infra-red radiation is even more injurious than that which reaches the retina.

When an electric bulb is seen directly and a similar bulb is seen through 0.4 inch of water, the bulb seen through the water appears brighter and whiter than the other, although some of its light must have been absorbed by the water. But the disagreeable sensation experienced when the eye is focused sharply on the naked glowing filament is not felt when the stratum of water is interposed. The difference in apparent brightness is produced in the eye, which accommodates itself to the total intensity of the radiation, both visible and invisible. This experiment shows that the sight is dulled, directly and immediately, by infra-red rays, and explains why a lower candle-power suffices with marble lights than with other devices. It is well known that very bright but uneven illumination is not fully utilized because the eye automatically cuts off part of it, while a perfectly uniform illumination, moonlight for example, is found brighter and more useful than photometric measurements would indicate.

In conclusion, I regard marble treated by Engel's process as an excellent material for lamp casings, because it is superior in translucency and equal in diffusive power to milk glass. It produces a pure white agreeable light without dazzling, and it absorbs the invisible heat rays more powerfully than any other equally translucent substance.

#### Removal of Blast Furnace Obstructions.

According to H. Schönweg, *Zeitschr. ges. Schiess- u. Sprengstoff.*, 8 (1913), 445-448, obstructions which completely prevent the passage of the blast in blast furnaces may be removed by dynamite without injuring the furnace. The charge is usually about 600 grammes, but may be as large as 1,250 grammes, provided it is exploded 40-50 centimeters from the furnace wall. The dynamite is fired by a fuse, the charge being contained in a tube inclosed in a second tube (in which it must have free play) projecting through a hole drilled in the furnace wall.—*Journal of Industrial and Engineering Chemistry*.



Ruined Spanish church beside the road from Dzitas to Chichen Itzá.



Portion of the ruins of the Nunnery or "Monjas" at Chichen Itzá.

## A Chapter of Ancient American History\*

THE wreck of human handiwork touches the heart, and none of us can fail to invest a ruined city with the purple haze of romance. At least, it is safe to say that no traveler in Yucatan and Central America can fail to be deeply stirred by the vestiges of ancient empire that lie scattered through the jungle. The ruins of Chichen Itzá, long famous on account of their size, accessibility and healthful situation, have been explained by fanciful tales or wrapped in impenetrable mystery according to the mood or stock of information of the person describing them. It does not detract from the wonder of this city or the grandeur of its buildings to say that the light of recorded history, somewhat faintly to be sure, shines upon its foundation, its periods of brilliancy and decadence and its final abandonment. But first let us view the monuments that time has spared.

To visit Chichen Itzá, which is situated in northern Yucatan not far from Valladolid, we leave the narrow gage railroad at the station of Dzitas, and then jolt for a never-to-be-forgotten fifteen miles over the solid limestone plain in a vehicle called a *rolan*. This word *rolan* means in Spanish "they fly," but judging by unhappy experience, "they leave the earth frequently and return

\* Reproduced from the American Museum Journal.  
† Photographs by the author.

By Herbert J. Spinden<sup>†</sup>



End view of the North Temple of the Ball Court.

The entire side surface of the North Temple, including the sloping walls of the vault and the round columns in front, is sculptured in low relief.

with emphasis" would be a better etymology to follow. The *rolan* is a high, two-wheeled cart which travels at top speed behind several mules. It has no seat for the passenger, but instead a sort of box, hung from a stiff frame, in which he reclines. As this primitive transport



Capitol of a rectangular column—lower chamber of the Temple of the Jaguars.

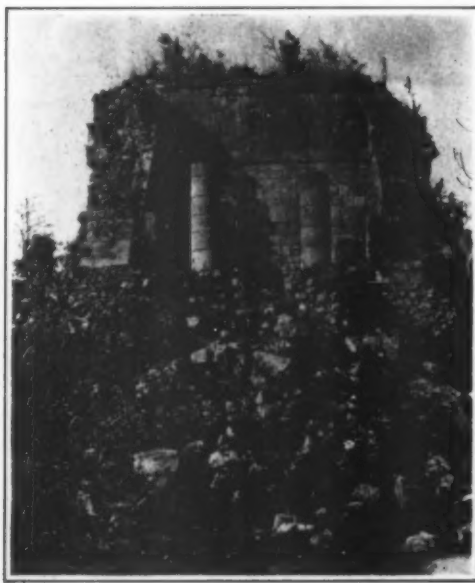
The design shows a grotesque face surrounded by three human figures. The man at the top bears a head-dress of leaves and flowers and holds flowering branches in his hand.

## The Story Told By Monument and Temple

lurches along the road, glimpses over the edge of the box may be caught of the tangled jungle on either hand, with here and there a trail making off to some *milpa* or cornfield. Finally, when misused flesh and bone can hardly stand another bounce, we arrive at the village of Pisté with its little cluster of palm-thatched huts. A few moments later, on rounding a curve, we flash into sight of a stone temple crowning a lofty pyramid—and about us lie the ruins of Chichen Itzá, a capital city of the ancient Maya empire.

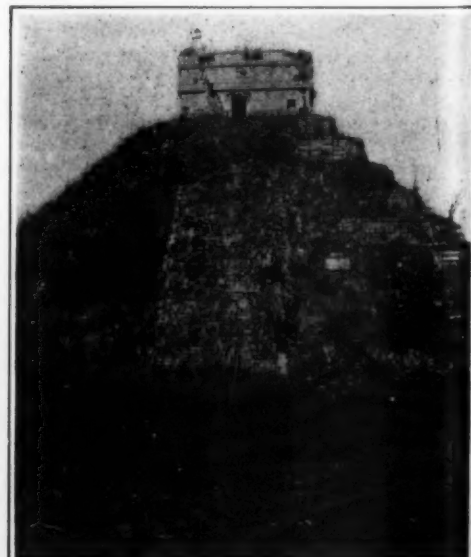
Northern Yucatan is a limestone plain without streams on the surface, but here and there the roof of a subterranean river has fallen in, making huge natural wells called "cenotes." At Chichen Itzá, there are two cenotes: one, commonly called the Sacred Cenote, was anciently used as a place of sacrifice where human victims were thrown into the pool below; the other, called the Grand Cenote, furnished water for the inhabitants of the city. The name Chichen Itzá means "the mouth of the wells of the Itzá." The Itzá were a tribe, clan or political division of the Maya nation, who have been named the Greeks of the New World.

At Chichen Itzá seven or eight structures are still in a fair state of preservation, but the bush for miles about is filled with heaps of cut stone that mark the sites of other buildings now in utter ruin. The most impressive structure is doubtless the Castillo or Castle—the temple



The North Temple of the Ball Court.

View showing the two cylindrical columns. The figures on the sculptured walls have never been drawn or carefully studied. In general the carvings show processions of warriors and priests similar to those of the lower chamber of the Temple of the Jaguars.



Castillo of Chichen Itzá.

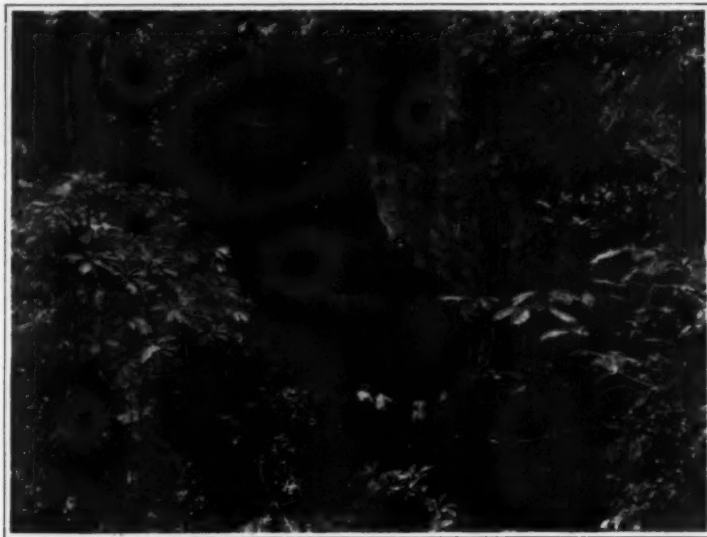
The Castillo is the loftiest temple mound at Chichen Itzá. The original cut stone facing of the terraces can be seen in places. A wide stairway ascended the pyramid on each side. Base of pyramid, 195 feet wide. Height, over 100 feet.





The Sacred Cenote into which human victims were thrown.

This great natural well is about eighty feet from the rim to the surface of the water. It was made by the falling of the roof of an underground river.



Great sink-hole in the limestone plain similar to the cenote.

Except that the caving in has not reached water level. Such a sink-hole forms a fairy grotto with its cool depths hung with vines and long thread-like roots.

on the pyramid seen as we entered the ruins. The pyramid rises steeply in nine terraces faced with cut stone and decorated with sunken panels, and on each side is a wide stairway with balustrades. The base of the pyramid measures 195 feet and its height 78 feet. The temple on the summit rises an additional 24 feet, so the structure as a whole is more than one hundred feet in height. This temple has on one side an ample doorway with two serpent columns, that lead into a vaulted portico. Directly behind this is the sanctuary. On the other three sides of the temple are doorways giving access to a narrow vaulted passage that leads neither into portico nor the sanctuary. The decoration of the temple consists of sculptured door jambs and lintels, all in bad repair; a mask panel or highly conventionalized serpent head in front view, on the outer walls above each door; two columns, already mentioned, that represent feathered serpents with the heads at the base and the tails serving as the capitol, and an open-work roof ornament reproducing the Greek meander.

From the shaded porch of Mr. Thompson's residence, we look across a lawn where the fountain plays and the orange trees hang their golden fruit, to a splendid relic of ancient glory—the great building known as the Monjas or Nunnery. This rambling structure, richly decorated with grotesque faces and geometric designs, is of especial interest to the archaeologist because it shows different periods of growth. In the first place, the substructure of the principal range of buildings has been enlarged several times, as is made clear by excavations leading into the solid mass. The ground level wing on the east was added after the substructure had received its final enlargement. The small chamber at the top of the Monjas, which may be called the third story, was not contemporaneous with the range of rooms beneath it, first because some of these rooms had to be filled in with earth to support the weight above, and secondly because the walls of this upper chamber are plainly made of reused material. There is good evidence that the sculptured details of certain other parts of the Monjas were taken from the wreckage of earlier buildings. In close connection with the Monjas are two small temples without substructures, the more interesting one being the single-roomed building called the Iglesia or Church. This little temple is decorated with mask panels, and has the front wall elevated one story above the roof, an architectural device known as the flying façade. This flying façade bears three mask panels which differ from each other and which are obviously made up of reused material.

West of the Monjas is the Akat'eib, the House of the Dark Writing, so called on account of some hieroglyphic inscriptions. North of the Monjas is the Caracol or Snail, a curious circular tower with a winding stairway.

Still farther to the north is the Casa Colorada or Red House, an admirably preserved building with a long outer chamber and three inner ones. The flying façade of this building is very pleasing with its mask panels flanked by

frets. Over the center of the roof rises another wall pierced by windows. This architectural detail, commonly called the roof comb or roof crest, is found in this single instance at Chichen Itzá, although often seen in other Maya cities.

Continuing in the same northerly direction, we encounter a temple upon a pyramid very similar to the Castillo, but smaller, which has been named the Temple of the High Priest's Grave. This rather fanciful title comes from a deep shaft on the floor leading down to a small burial chamber. In conjunction with this temple are some small platforms which are believed to have been used as stages for dramas or religious ceremonies. Several of these platforms, having stairways on the four sides, and sometimes sculptured panels, are found at Chichen Itzá.

Northwest of the Castillo lies the Ball Court Group with the famous Temple of the Jaguars. The South Temple of this group is a plain building of little interest, but the North Temple is very interesting because its entire inner surface, including the sloping surfaces of the vault and the round columns in front, is a mass of sculptured detail in low relief. The carvings deal with processions of priests and warriors similar to those on the wall of the Lower Chamber of the Temple of the Jaguars. The Temple of the Jaguars is situated at the southern end of the parallel stone walls of the court. The inner chamber of this temple has excellent frescoes in low relief, while the lower chamber at the base of the wall has painted sculptures. The last group of buildings which we have time to consider is the group of the Columns in the western part of the city. In this extensive ruin there are great rows of columns on platforms as well as several interesting temples. It has been suggested that this part of the city was a market, but nothing that really confirms such a belief has come to light. The temples are mostly of the same general type as the Castillo, with sculptured door jambs and serpent columns. Several of these temples have been only partly excavated. One of the most interesting is the Temple of the Tables, which takes its name from a table-like altar supported on the uplifted arms of small Atlantean figures. So much for the buildings of Chichen Itzá: let us now examine the question of history.

When Grijalva and Cortes sailed their caravels to the low-lying, palm-fringed coast of Yucatan in 1517 and 1518, they found the Maya Indians in a state of advancement that excited wonder and admiration. Yet we know from many documents that not a single one of the great stone-built cities was really occupied at this time. Great



Atlantean figure carved from a single block.

At Chichen Itzá occur table altars, consisting of a flat stone carried upon the heads and hands of figures of this sort.



Photo by F. M. Chapman.

Temple of the Tables.

Showing sculptured door jambs and stone figure used as altar support. These table altars have given the temple its name.



Carved stones from temple walls.

Serpent heads, death heads, and other sculptured figures lie scattered about in the brush, awaiting the careful study of the archaeologist and student of primitive art.



The lower chamber of the Temple of the Jaguars.

A mass of interesting sculptures which were primarily painted and which show processions of warriors who bear tributes to various gods.



Detail of the sculptured lower chamber of the Temple of the Jaguars.

The stones seem to have been carved after they were put in place in the wall. Traces of color are still discernible.

trees were growing from the roofs of the buildings at Uxmal, and while Chichen Itzá was a place of pilgrimage and sacrifice, it is pretty clear that the temples we have just seen were all abandoned and in partial ruin. To restore the history of Chichen Itzá, we must review our knowledge of the other great Maya cities situated not only in northern Yucatan but also far to the south and west in Guatemala and Honduras.

The restoration of Maya history depends upon three lines of study which must be carefully brought into relation, each with the others—namely, traditions, inscriptions and natural developments in art. The first of these is, at first sight, most intelligible. Brief chronicles, called Books of Chilán Balam, were preserved at several towns in northern Yucatan. These chronicles were written in Spanish letters but in Maya words by educated Maya Indians during the sixteenth and seventeenth centuries, and were doubtless based upon earlier native documents which contained hieroglyphs and pictures. The events of history recorded in these chronicles are fixed with reference to the katuns or twenty-year periods of Maya chronology. These katuns are distinguished from each other by the numbers one to thirteen, which fall in a peculiar order. Any date in the chronicles is definite for a cycle of thirteen times twenty, or 260 years. But by putting down all the katuns which passed, whether or not there were historical entries opposite them, the Maya historian prevented confusion in the 260-year cycles and actually carried the historical count over a stretch of seventy katuns, or 1,400 hundred years, before the coming of the Spaniards.

Now let us glance at the second line of research—the inscriptions. These are found on monolithic monuments, lintels, tablets and other objects. The inscriptions of the greatest value to the student of ancient American history are those expressing dates in the so-called archaic Maya



Sculptured column, Temple of the Tables.

The use of square and round columns at Chichen Itzá transforming the outer room of the temple into an open portico, is a great advance over the simple doorways of the earlier Maya buildings.



Mask panel, front view of modified serpent head, on frieze of Nunnery foundation.

The nose formerly projected a foot or more from the wall. A small human face is seen above the serpent nose.

calendar. This archaic calendar is essentially the same as the one used in the Books of Chilán Balam so far as the length of the katun is concerned, but by another system of naming the katuns, the danger of confusing the 260-year cycles is overcome. Dates in the archaic calendar are exact over vast stretches of time. The most valuable data are found in what is called Initial Series, and of these over fifty have been deciphered. The Initial Series is really a number which records the days which intervene between a beginning day, in all cases the same, and the day given in the inscription. We count the years



Design on door jamb, showing classical idea of Atlantean support of weight above.

from the birth of Christ, the Maya count the days from a beginning day, that according to our system falls about 3,600 B. C. Nearly all the Initial Series dates known occur at the southern cities of the Maya area, but one very important date of this sort occurs at Chichen Itzá. Indeed it is this date which has made possible a correlation of the archaic Maya calendar with the calendar used in the Books of Chilán Balam.

But dates that are simply dates mean very little; to be of value they must be associated with events. Now while we can read the dates in Maya inscriptions, we can do very little with the remaining hieroglyphs that probably tell the significance of these dates. A third line of research enables us, however, to prove what dates are, in all probability, contemporaneous with the monument on which they are found, and what dates refer to the past or future. Progressive changes in style of sculpture and progressive adaptation of superior mechanical devices in architecture enable us to arrange many works of art in their proper time sequence, but do not, of course, enable



The plumed serpent in the sculptured lower chamber of the Temple of the Jaguars.

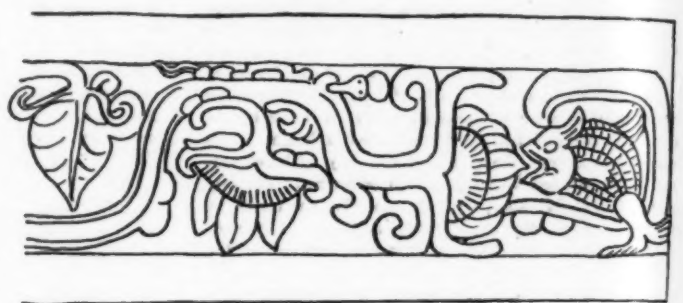
This may be identified with Kukulcan, the Maya equivalent of Quetzalcoatl. (Drawn from carving shown in first illustration on this page.)



A human-like head in the distended mouth of a plumed monster.

The claws of the monster are seen at the bottom and between them hangs the great forked tongue.

us to express this time sequence in terms of years. Space does not permit a full explanation of this complicated subject which, however, the writer has elsewhere given in detail. Suffice it to say that by carefully co-ordinating the three lines of study just explained, an outline of the course of Maya history is made possible. The following



Winding plant motive with intrusive serpentine details, from Chichen Itzá.

names and limits have been suggested for the various periods:

Protohistoric Period.....	235 B. C. to 160 A. D.
Archaic Period.....	160 A. D. to 455 A. D.
Great Period.....	455 A. D. to 600 A. D.
Transition Period.....	600 A. D. to 960 A. D.
League Period.....	960 A. D. to 1195 A. D.
Nahua Period.....	1195 A. D. to 1442 A. D.
Modern Period.....	1442 A. D. to ?

Now let us see what place Chichen Itzá occupies in this historical vista. Several of the chronicles relate that



Sculptured column made of drum-shaped sections.

From the South Temple of the Ball Court. The designs represent warriors, reclining figures and a wealth of highly conventionalized serpent heads interwoven in a phantastic pattern.





Panorama of the ruins of Chichen Itza.

In the foreground at the left are the Nunnery buildings, the smallest, the single-roomed temple figured on front page; in the background and to the right is the Castillo, with its lofty stepped pyramid, while immediately to its left is the Ball Court Group of ruins, including the famous Temple of the Jaguars. Two cenotes are shown, the Grand Cenote at the right of the center, and a second in the extreme central background. The tops of the ruins of Chichen Itza rise above the tree-tops of a forest which everywhere gives rich color to the plain. The function of the various buildings is thought to have been mainly religious. The names given to the ruins serve only for convenience in description; they may not be appropriate.

Chichen Itza was discovered during a residence of the Itza at Bacalar on the east coast of Yucatan. By the term "discovered" is probably meant that the cenotes which made habitation possible were discovered. The settlement was made about 450 A. D. at a time when the southern cities, such as Copan and Tikal, were entering upon their most brilliant epoch. It seems certain, however, that Chichen Itza was only a mediocre provincial town at this time. Only one dated stone has been found, and this is poorly carved. The date upon it corresponds to 603 A. D. Shortly after this date, Chichen Itza was abandoned, and the Itza went to the land of Chanputun, near Campeche, where they stayed according to the chronicles, for 200 years. Somewhere near the middle of the tenth century, they made their way back to the north and re-established Chichen Itza. At about the same time, Uxmal and Mayapan were likewise founded, and a league between the three was instituted. This League of Maya-

pan, as it is commonly called, endured for over 200 years and controlled the destinies of northern Yucatan. Trouble between the allies broke out with the Plot of Hunac Ceel, the chief of Mayapan, and as a result the hereditary ruler of Chichen Itza, whose name was Chac Xib Chac, was driven out in 1176. A disastrous war, lasting 34 years, took place, and the ruler of Mayapan seems to have enlisted seven warriors from the highlands of Mexico under his standard. These men have Nahua names. In all probability, the conquered city was given over to them as the spoils of war at the end of the long contest. After this, however, there seems to have been little in the way of peace. Civil wars rent the land, and while we cannot put an exact date on the final fall and abandonment of Chichen Itza and Uxmal, it is probable that these events occurred somewhere in the fourteenth century. Mayapan, the last city to survive, fell in 1442, almost a hundred years before the Spaniards

made their first really permanent settlement at Mérida.

When we try to arrange the buildings of Chichen Itza in their proper order of erection, it is remarkable that so many of the finest structures clearly belong to this last short period when the city was in the hands of foreign rulers from the distant Mexican highlands. It is unlikely that a single structure of the first occupation of Chichen Itza will be found in a good state of preservation. The stone with the early date that has already received comment is a lintel that was probably taken from an old building and is reused in a later one. There are, however, a number of structures that probably date from the second occupation when Chichen Itza was a purely Maya center. The Akat'eib and the Casa Colorada are Maya structures without a trace of foreign influence. Most of the Monjas Group is also Maya without modification. The Castillo, the Temple of the High Priest's Grave, the entire Group of the Ball Court and the Group of the Columns date in all probability from the foreign régime, and consequently cannot have been erected before the last quarter of the twelfth century. The architecture of these buildings as well as the sculptures show strong resemblances to work in Tula, Teotihuacan and other sites in the valley of Mexico. The native religion seems to have suffered from the foreign infusion also. New forms appear in the religious art, and it is not unlikely that the human sacrifice at the Sacred Cenote was inaugurated by the intruders. The game played in the Ball Court seems not to have been known by the Maya in earlier times, and indeed the only examples of ball courts in Yucatan are seen at Chichen Itza and Uxmal.

This, in brief, is the story of Chichen Itza. Founded when the Huns, under Attila, were battling with the failing armies of Rome, it was abandoned for the first time when Mohammed was laying the heaven of Arab conquest. Re-established in the era of the Saxon kings, it flourished during the Crusades, and lost its freedom to a foreign power when our fathers were struggling for the Magna Charta, and sank into oblivion while the English and French fought out the Hundred Years' War. Surely a city with such a history can hardly be dismissed as void of interest and inspiration.

## Strength of Shafting Required to Transmit a Given Horse-power at Different Speeds

Table Computed and Prepared by C. H. Clark

$d$  = Diam. of Shaft

$R$  = R. P. M.

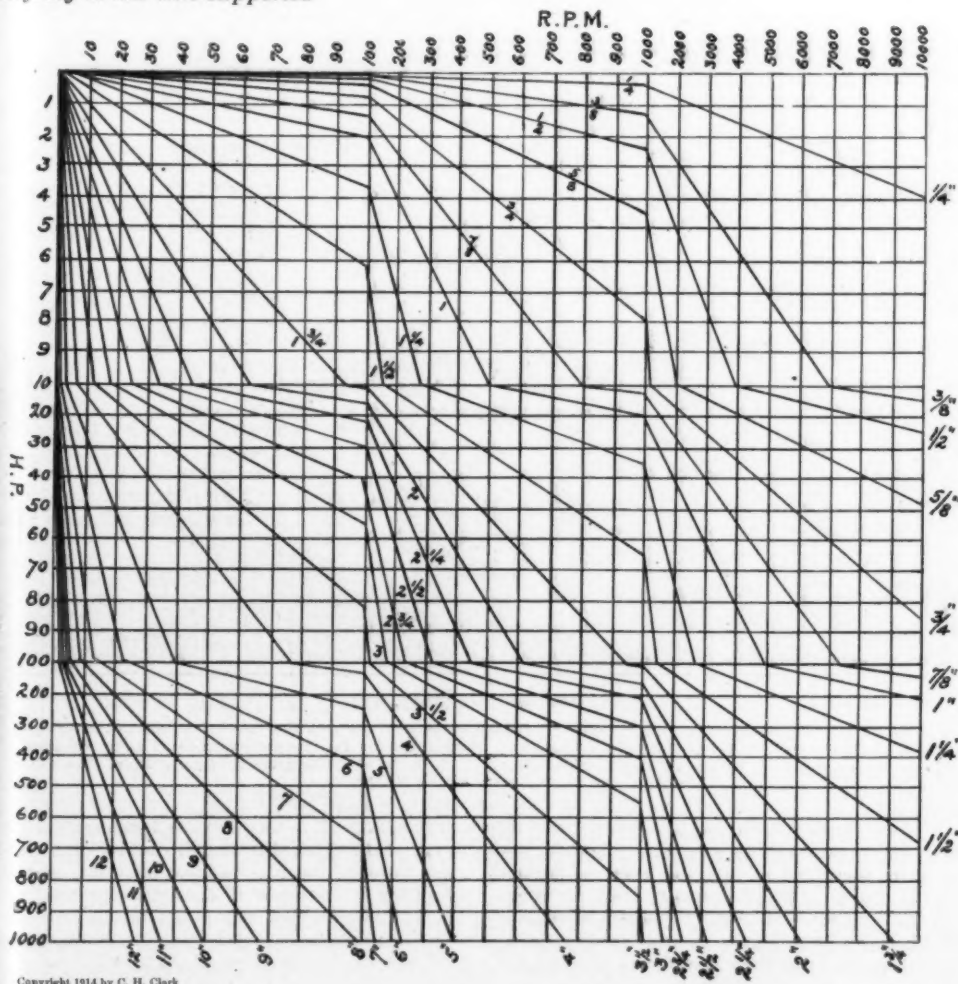
Substitute 100 for 50 if

shafting is not well supported

$$H.P. = \frac{d^3 R}{50}$$

$$d = \sqrt[3]{\frac{50 \times H.P.}{R}}$$

$$R = \frac{H.P. \times 50}{d^3}$$



Copyright 1914 by C. H. Clark

## Plasmodium Tenue, a New Malarial Parasite of Man

SIR RONALD ROSS has just communicated to the Royal Society of London the discovery, by Dr. J. W. W. Stephens, professor of tropical medicine at the University of Liverpool, of what he believes to be a hitherto undescribed malarial parasite of man. It was first noticed in a blood-slide from a native child in the Central Provinces of India. A striking peculiarity of the Indian parasite is its decided irregularity of form as compared with the regular, almost monotonous contour of the "rings" of the malignant tertian parasite (*Plasmodium falciparum*). The new species, to which the name *Plasmodium tenue* has been given, is extremely ameboid, judging from the stained specimens. Thin processes often extend across the cell or occur as long tails to more or less ring-shaped bodies. There may be several of these processes, and they may give the parasite most fantastic, irregular, web-like shapes. The cytoplasm is very scanty. The nuclear chromatin is out of proportion to the volume of the parasite, and the abundance of the chromatin masses, as well as the marked irregularity in their distribution, seems to be characteristic of the parasite.—*Journal of the American Medical Association*.

## Some Statistics on German Universities

SOME interesting statistics about German universities are given in a recent issue of the *Chemiker-Zeitung*. During the academic year, August, 1911, to August, 1912, 4,455 doctors' degrees were given, 83 more than in the previous year; these were divided among the various faculties as follows: Theology, 55; law and political science, 1,265; medicine, 1,343; philosophy and natural science, 1,792. The percentage of students who receive degrees in the different universities and faculties varies from 87.6 per cent in law at Erlangen to 0.2 per cent in law at Berlin.

The salary of rector varies in an astonishing way at different universities. This position is, of course, quite different from that of president in an American university, for the rector is elected from the faculty by his colleagues for a short term. In Berlin the rector's salary is about \$9,250, in Kiel \$800, while in the Academy at Braunsberg it is slightly more than \$20. The average is about \$1,500. The salary of the deans of the various faculties varies even more, ranging from \$5,500, the salary of the dean of the faculty of philosophy at Berlin, to \$5, the compensation of the head of the theological faculty at Halle.—*Journal of Industrial and Engineering Chemistry*.



The bowfin group.

To illustrate the nesting habits of the bowfin, or mudfish. At the left the male and female fishes are seen on a nest; at the right a male standing guard over the eggs.



Detail of the bowfin group.

This photograph of a portion of the group shows the male bowfin poised over the nest guarding the eggs against intruders. [The eggs appear as white dots in the picture.]

## The Life Habits of Fishes\*

### Exhibits in the American Museum

By Bashford Dean

It is an open question to what degree the life-habits of fishes should be pictured in an elaborate way in the Museum's present gallery of fishes, for space is limited and such "habitat groups" occupy many cubic feet. It is clear, too, that they are subsidiary to other types of exhibits, thus, the principal kinds of fishes must be shown as casts, alcoholic specimens or stuffed, and there must be models and preparations to illustrate how fishes move, breathe, and have their being generally, how they reproduce their kind, how they may be curiously adapted to living in shallows, surf, the depths of the sea, on land, and even flying in the air, how they change colors when they sleep, or when, chameleon-like, they adjust themselves to their surroundings. All exhibits of the latter types may be developed attractively on a fairly small scale, and will interest and teach the

\* Reproduced from *The American Museum Journal*.

average visitor to the Museum, and will satisfy as well a need of the serious reader of zoology.

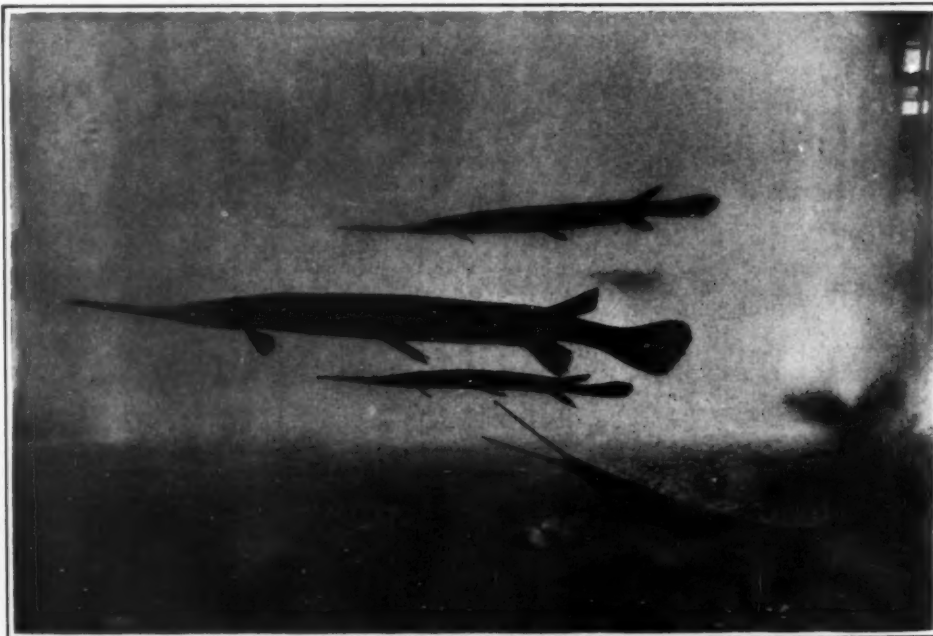
Great habitat groups, on the other hand, are elaborate exhibits with painted backgrounds, artificial plants and rocks and "effects" which entail much time to construct, great expense, and infinite pains to supervise and execute. The results, it is true, are apt to give an impressive and accurate picture of certain phases in the life of fishes, and are certainly a definite and æsthetic means of attracting the visitor to a more careful study of neighboring exhibits, whetting his appetite for a more serious zoological diet, so to speak. Still, even at the best, the habitat groups of fishes are not to be compared with those of mammals, birds or reptiles, for fishes are least suited structurally to the art of the taxidermist or of the modeler. Scales and fins shrink, colors fade, and the mounted fish, no matter what its pose, appears only too often as a dead fish, opaque and leaden. It follows, therefore, that with our technical methods, extensive fish groups can hardly be expected to rival the tanks of an aquarium.

In our present gallery, accordingly, it has been the

Thus, the lowly lampreys are represented in a group which shows such details as swimming, excavating their nest and depositing their eggs. And the ganoids are now pictured in four large groups. For the ganoids are the few survivors of one of the great divisions of fishes in early geological times, and formed the evolutionary bridge which connected the primitive sharks on the one hand with lungfishes, and on the other with the bony fishes, which form perhaps over ninety-nine per cent of all living fishes. In these four habitat groups, the first pictures the shovel-nosed sturgeon, which still occurs in the Mississippi and its tributaries, and is to be regarded as the least modified of all living ganoids. The second shows the spoonbill sturgeon, which, on the contrary, is the most highly modified member of the ancient stock. This eccentric sturgeon has survived only in this country and in China, and is here verging perceptibly toward extinction, for its immature spawn is used as caviar and our fishermen have devised means of well-nigh exterminating it. The third group exhibits the spawning habits of the gar pike, whose close-set armor of enamel plates suggests at once the bony- and



Portion of the transparent background of the bowfin group to show the painting of the male bowfin with the swarm of newly-hatched young.



The Gar pike group.

A party of gar (*Lepisosteus osseus*) just after spawning. At the right are seen the "weeds," among which the eggs (shown as white dots in the picture) were deposited. The studies for the group were made at Lake Nemadji, Wisconsin, in June, 1912, by Messrs. Dwight Franklin and A. E. Butler of the department of preparation. The fishes were mounted and colored in the field from living specimens, by Mr. Franklin.

aim to show larger habitat groups only in those instances where the fishes form important links in the chain of the backboneed animals, and touch the broader phases of natural history, especially from the viewpoints of structure and descent. In such cases, too, the effort has been to demonstrate essential habits or interesting facts concerning their breeding or development.

glossy-scaled fossil fishes which one finds abundant from the age of the Old Red Sandstone onward. The fourth group shows a ganoid which has nearly attained the appearance and structure of a modern bony fish. This is the dogfish or bowfin, *Amia*, which though known fossil from many parts of the world, is practically restricted to-day to the waters of the Middle West.

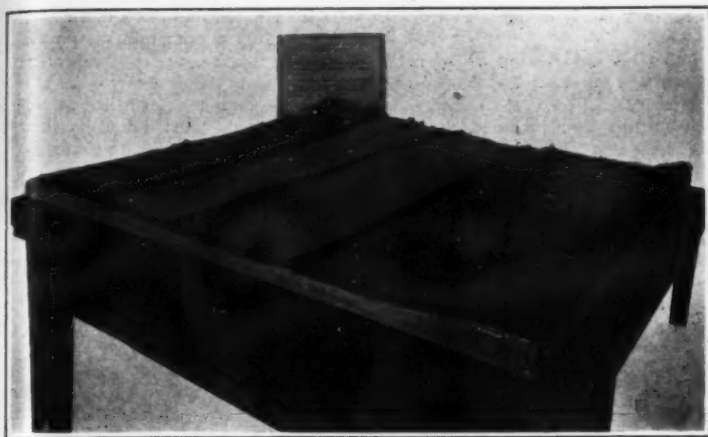


The last three groups mentioned have lately been placed on exhibition. They are the work of Mr. Dwight Franklin, of the Museum's department of preparation, who collected the material and carried out its preparation with the greatest care. The plant-life accessories in the *Amia* group were executed by Mr. A. E. Butler,

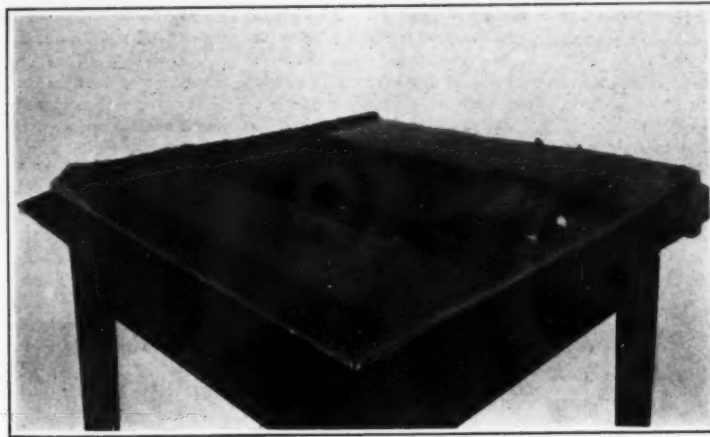
also of the Museum's staff, who had the advantage of visiting Mr. Franklin in the field.

It may be said that the department of ichthyology of the American Museum hopes to prepare at some time in the near future a similar habitat group to show the important division of fishes represented by the living

sharks and rays, still another group to picture the life of the lungfishes, and several groups to represent the bony fishes—one showing the life habits of pelagic forms, another, which is now well in hand, will picture the "phosphorescent" fishes of the deep sea, and still another the fishes of rocks and surf and corals.



Plan of windbreaks on a 160-acre farm in Oklahoma. Osage orange, honey locust, green ash, or red cedar should be used.



Model of plan for location of windbreaks on a 160-acre farm in the northern prairies.

## Trees as Windbreaks for Land Under Cultivation

Models Prepared by the Department of Agriculture

THE two windbreak models shown on the accompanying photographs give the proper locations of windbreaks on a 160-acre farm in the northern prairies, including eastern Montana, the Dakotas, and southern Minnesota, and in Oklahoma, western Texas, and adjacent regions. Windbreaks are valuable in three ways: first, they lessen evaporation; second, they protect crops from mechanical destruction wrought by the wind; and third, they protect livestock, houses, and barns from the hot winds of summer and the chilling winds of winter, thus rendering homesteads more habitable, and the livestock more comfortable. Livestock protected by windbreaks needs less food in winter to keep up body warmth, and are more comfortable and remain in better condition during the summer. Evaporation may be lessened not only by keeping the mulch cover of the ground well pulverized, but by lessening the force of the wind. The latter may be accomplished by placing forest windbreaks at frequent intervals throughout the farm, at right angles to winds prevailing during the growing season. The Forest Service has made careful and extensive study of the needs and value of windbreaks throughout the Middle West. It has determined the species best suited for windbreaks in the various regions, has carefully and accurately worked out both the harm done to crops by windbreaks, through sapling and shading, and the beneficial protection which accrues from their use, and has drawn a balance greatly favoring their establishment and maintenance. The published results of these investigations point out the manner in which trees should be placed in windbreaks, the width which the windbreaks need to have for best efficiency, the area over which windbreaks of given heights are effective, and other details valuable to the farmer who wishes to take advantage of them.

The windbreaks shown on the model of the Oklahoma farm run east and west, with a grove windbreak running north and south on the west edge of the farm. These windbreaks are placed in this way because the prevailing injurious winds during the growing season in this section of the country are mostly from the south. The windbreak on the southern edge of the farm is about ten rods through and protects a field about sixty rods in width. The other windbreaks are single row hedges, carrying their protection over to narrow fields becoming narrower as they are at greater distances from the grove windbreak on the southern edge of the farm. The north and west row on the west side of the farm is to help give protection from the southwest winds. While severe winds come from the north in this region, these winds are usually of short duration and do not occur frequently during the growing season. Such drought resistant hardwoods as Osage orange, green ash and honey locust, supplemented by Scotch and Austrian pine and red cedar, will make the best windbreaks for this region. Where hardwood trees which lose their leaves in winter are used, they should be supplemented by evergreens in order to furnish protection in winter as well as in summer.

The prevailing injurious winds in the northern prairies are the cold and dry winter winds from the northwest, and, secondarily, the occasionally dry westerly winds of summer. The warm chinook winds occurring in the early spring may have damaging consequences. To meet these, windbreaks of both orientations must be used, with about two of the north-south to one of the east-west. Conifers should be used for windbreaks in this region exclusively. There should be a belt of about seventy-five feet containing twelve rows of pines, and three rows of spruces on either side running along the north and west borders of a 160-acre farm, and two such rows extending north and south through the farm at intervals of about sixty rods. This will make about thirty-six acres of timber for the farm, will increase the productivity of the crops, and will allow at the end a large amount of material suitable for fence posts and other farm uses, and even for box boards for commercial purposes. On poor situations, the belts should be only 60 feet wide, but there should be an extra one running east and west on the farm.

## Whales in the Mediterranean

THE sea-monster (popularly supposed to have been a whale) cast ashore last September at Beaulieu, has been identified as the *Ziphius cavirostris*, a cetaceous mammal. Although not a "true" whale, like the Greenland right whale (*Balena mysticetus*), or the Nordkaper or Biscayan variety (*Balena biscayensis*) of the same species, the *Ziphius* can certainly claim, in common with the narwhal, grampus, porpoise, etc., a relationship with the whale family.

The carcass of this animal has been secured by the authorities of the Museum of Oceanography at Monaco, where the skeleton, when mounted, will be added to the collection.

This is not the first *Ziphius* which has strayed into Nice waters. The skeleton of one, washed ashore at Villefranche in 1866, is in the museum at Jena. Another, captured by some fishermen off Beaulieu in 1878, measuring 5.60 meters (18 feet 4 inches) in length and 3.70 meters (12 feet) in girth, is in the Natural Museum at Florence. Another, captured at St. Jean, is at Brussels, and other specimens are to be seen in the museums at Turin, Monaco, etc.

Little is known concerning the habits of this creature, which takes its name, *cavirostris*, from the deep cavity on the underside of the snout. Its color is a bluish black, with patches of a darker shade on the back. The belly is white. It inhabits the Pacific Ocean, where it feeds principally on small fish, cephalopods and many other forms of marine invertebrates.

The Commandant Caziot, president of the Association des Naturalistes des Alpes-Maritimes, and curator of the Natural History Museum at Nice, has published an interesting memoir on the Cetaceans found on this coast, entitled "Liste des Cétacés observés dans la mer de Nice." In this he affirms positively that no "true" whale has been found in the Mediterranean Sea. In this work a list of no fewer than sixteen different species of Cetaceans that have been seen or captured in these waters is given. Of this number the museum at Nice, unfortunately, only possesses three specimens, viz., the *Tursiops tursi*, *Delphinus delphis* and the *Grampus Rissoanus*. The four members of the *Ziphius* tribe, viz.,

the *Ziphius cavirostris*, *Hyperood rostratum*, *Meroplectron Sowerbyi* and the *Catodon macrocephalus*, or cachalot or sperm whale, sometimes found in the Mediterranean, are included in this list.

Among others which have been captured in these waters may be mentioned the finner whale (*Balænoptera musculus*) and two others of the same genus, the *B. physalus*, one of which, 20 meters (65 feet 6 inches) in length, was harpooned by the crew of the yacht "Princess Alice," belonging to the Prince of Monaco, in the waters of the principality a few years ago. The other, the *Balænoptera rostratus*, is not infrequently met with in the Mediterranean also. The *Phocæna communis*, the common porpoise frequently met with on this coast, figures in this list, which includes the bottle-nosed whale (*Balænoptera hyperoodon*), as well as several varieties of the dolphin tribe, such as the *Sterno rostratus*, *Globiceps melas*, *Orca gladiator*, *Grampus griseus* and the *Prodelphinus tethys*.—*Journal of the Royal Society of Arts*.

## The Origin of a Borax Mineral

It is generally recognized that boric acid in considerable quantities is an original constituent in the waters and gases given off with volcanic emanations. In fact, the Tuscan fumaroles in Italy have been an important commercial source of boric acid for a long time, and in the past, possibly even to the present time, almost all the boric acid brought into the European market has been derived from this source. There is abundant evidence of the presence of boric acid in volcanic emanations in many parts of the world. On the other hand, boron is so rare a constituent of rock-forming minerals that it forms an almost inappreciable small percentage of the earth's rock mass as a whole.

A short study of the borate deposits in Ventura County, Cal., supplemented by more cursory examinations of similar deposits in the vicinity of Death Valley, has been made by Hoyt S. Gale, of the United States Geological Survey, and a new theory of the origin of the deposits of colemanite, or borate of lime, in these regions has been advanced by Mr. Gale in Professional Paper 85, Part A, recently published by the Survey. While this theory has not yet been entirely proved, there is much in its favor, and it affords suggestions and a working basis for further observation.

The supposition of a desiccated saline lake to explain the origin of the colemanite has little to support it beyond rather general assumptions. The character of the deposits themselves indicates rather a vein type of formation. Other salines which would naturally be expected in desiccation deposits resulting from natural saline solutions are not found in association with the colemanite. Those who have supported the desiccation theory have offered no explanation of the cause which might produce colemanite in such massive deposits as a product of water evaporation while, on the contrary, its formation from limestone in veins by replacement of carbonic acid with boric acid is a natural hypothesis that deserves further investigation. The relations of the deposits to basalt lava flows indicate the probable origin of the boric acid at the time of the extrusion of these lavas, although it may be assumed that this acid continued to find its way into solution of the circulating ground waters long after the period of the extrusions.—*The Chemical Engineer*.



# Blasting Gelatine: Some Notes and Theories\*

## Improved Method of Mixing Ingredients to Prevent Exudation Troubles

By W. A. Hargreaves, Chief Inspector of Explosives, South Australia

BLASTING gelatine is the most powerful explosive in general use for mining purposes, and it forms a base for a general class of high explosives called "gelatines." It is officially defined as consisting of nitro-cotton, carefully washed and purified, combined with thoroughly purified nitro-glycerin in such proportions that the whole shall be of such character and consistency as not to be liable to liquefaction or exudation, and with or without calcium or magnesium carbonate not exceeding two parts by weight in every 100 parts by weight of the finished explosive. In actual practice, blasting gelatine consists only of nitro-glycerin and nitro-cotton.

The ordinary process of manufacture is to add to nitro-cotton of known gelatinizing power the calculated quantity of nitro-glycerin in the cold, and mix roughly by hand; then after standing for some hours the temperature is raised and more complete incorporation is made, usually in a mixing machine. Since different lots of nitro-cotton may appear to have different gelatinizing powers, and since the tendency to exudation of nitro-glycerin from the finished blasting gelatine appears to depend in some way on the nitro-cotton, manufacturers have used varying percentages of nitro-cotton which have been as low as 7 per cent and as high as 9 per cent in blasting gelatines brought to South Australia.

Over 14 years' experience as an Inspector of Explosives has shown me that manufacturers, even the best, have not been able to arrive at a definite quantity of nitro-cotton to use, and also have not been certain of producing every time a blasting gelatine that will comply with the official definition given above. So far as nitro-glycerin is concerned, there has been no trouble for many years, owing to the fact that it is a homogeneous liquid and can be thoroughly washed free of all the impurities which are liable to make it unstable. In the case of nitro-cotton, the difficulties are great, owing to its physical condition, and there is always the possibility of small impure particles remaining in the cotton surrounded and protected from the washing liquid by the colloidal matter of which the nitro-cotton is composed. The particles may be only the size of pin points, but they may serve as centers of instability, so that when the blasting gelatine is subsequently submitted to the "heat test" a low result may be obtained. It is quite a common experience in the case of blasting gelatine, which has been condemned on account of low heat test, to find that one portion of a cartridge will give a low test, when other parts of the same cartridge may pass the test. Apart from the difficulty of low test, which can be minimized by extra care in the preparation of the colloid cotton, there is also the more common trouble of exudation of nitro-glycerin. This, indeed, may be regarded as the chief difficulty that manufacturers have to face, for no brand of blasting gelatine imported to Australia is free from liability to exude nitro-glycerin when subjected to the trials of the voyage and the storage after arrival. Time after time, shipments of blasting gelatine have to be condemned, wholly or in part, on account of this exudation.

It is evident, therefore, that either the true nature of blasting gelatine has not been understood or else the means of avoiding this defect have not been known. The usual and accepted remedy has been to increase the proportion of nitro-cotton, but this is open to several grave objections. In the first place, if the percentage of nitro-cotton is too high, the risk of getting a low heat-test explosive is increased; secondly, the blasting gelatine is likely to be insensitive to detonation by the ordinary No. 6 detonator; thirdly, the balance of oxygen is likely to be upset, so that, owing to the reduced percentage of nitro-glycerin, the generation of carbon monoxide is increased; and fourthly, the cost of the explosive is greatly increased. The last is by no means the least important from a manufacturer's point of view.

To find what is the real nature of blasting gelatine is, therefore, a problem of importance. Direct experiment and observation can teach much, but the difficulties of arriving at knowledge by pure deduction are very great, and one is perhaps justified in erecting on the foundation of a few observed facts a hypothesis which can be tested by subsequent observations and experiments. As my hypothesis has stood the test of four or five years' careful observation by those who are well qualified to form an opinion, I am now publishing it in the hope that it will help manufacturers to overcome some of their difficulties, and that it will be of assistance to those who, like myself, frequently have the grave responsibility of

dealing with explosives which do not completely satisfy the official definition referred to above.

The theory is that blasting gelatine, instead of being a solution of a small quantity of nitro-cotton in a relatively large quantity of nitro-glycerin, is in reality a colloidal solution of a certain quantity of nitro-glycerin in nitro-cotton intimately mixed with some free ungelatinized nitro-glycerin.

Bütchli has described a hydrogel as having a fine webbed micro-structure. This description has not been unanimously endorsed, but it conveys an idea of the mechanical condition of a jelly which explains some facts. Assuming for the present that a hydrogel has some such structure, it may take up in the meshes proportions of water which will vary with the size of the meshes, with the size of the threads or fibers constituting the structure, and possibly with the nature of these jelly "fibers," their power of adsorption, etc. It has been shown that silicic acid and other colloidal substances may be obtained with varying amounts of water of hydration. It may be assumed that a similar thing occurs in the case of blasting gelatine, where a solution of nitro-glycerin in nitro-cotton or *vice versa* produces a gel having apparently the properties of a finely webbed structure, which adsorbs or otherwise entangles liquid nitro-glycerin in the meshes. The proportion of nitro-glycerin so held will vary chiefly with the size of the meshes and the size of the filaments or "fibers" of the gel. Hence blasting gelatines apparently similar in all outward respects may be obtained with varying ratios of nitro-cotton to nitro-glycerin, and they may lose varying quantities of nitro-glycerin by exudation without making any apparent change in the appearance of the jelly. We have assumed that a portion of the nitro-glycerin has "dissolved" in the nitro-cotton. As this is not quite the same thing as a chemical combination, the quantity of nitro-glycerin so dissolved will be subject to some amount of variation without making much change in the appearance of the jelly. Assuming that a given quantity of a certain nitro-cotton can "dissolve" a certain quantity of nitro-glycerin, but that owing to mode of manufacture it has dissolved or combined with a less quantity, and formed a jelly of quite satisfactory appearance, then it is reasonable to suppose that the nitro-cotton will go on "dissolving" more nitro-glycerin at a diminishing rate till it is saturated. The saturation point will probably depend on the temperature and on climatic conditions. There will, however, be a difference in this action from the original solution in so much as, while in the first instance nitro-glycerin is in contact with nitro-cotton, now nitro-glycerin is in contact with a jelly, and owing to the physical nature of this jelly in impeding contact of nitro-glycerin with the nitro-cotton unacted upon or not saturated, the final stages of solution will be very slow, and only likely to occur on prolonged storage of the explosive. It seems reasonable to suppose that if a manufacturer has calculated a quantity of nitro-cotton based on its observed gelatinizing power as determined in the laboratory, but that owing to the fact of exudation having occurred with a similarly made blasting gelatine, he is tempted to increase the percentage of nitro-cotton, it may happen that on prolonged storage the whole or almost the whole of the free nitro-glycerin goes into solution. The result is that there is produced a blasting gelatine which is either wholly a jelly or is such that the minute particles of free nitro-glycerin in the interstices are far apart and separated by walls of jelly.

The second part of my hypothesis is that in blasting gelatine, the explosive wave following detonation is transmitted by the free nitro-glycerin, and only imperfectly or not at all by the jelly. If there is no free nitro-glycerin or the particles of it are too far apart, the blasting gelatine becomes "insensitive." It has been shown by Dr. Comey and others that the nitro-glycerin contained in 75 per cent dynamite transmits the explosive wave at a velocity of between 6,000 and 7,000 meters per second, and nitro-glycerin in an iron tube of large enough bore will give a rate of over 7,000 meters per second, but for a 10 per cent dynamite the rate is only 2,000 meters per second, which is about the rate for gelignite unless the wave gets a greater impetus from the explosion of a dynamite primer. Even then the wave slows down as it progresses, inversely as the percentage of nitro-glycerin in the gelignite. It appears therefore, that if the amount of free nitro-glycerin in a gelatine is small, and the particles are far apart, or the connecting threads or surfaces have small sectional area, or if there is no free nitro-glycerin at all, the rate becomes that of the jelly itself. From its physical nature it presents a buffer to the initial shock and deadens the subsequent wave. Hence the blasting gelatine in these

circumstances is "insensitive" and inert, and requires a stronger detonator or even a primer to get proper explosion. Such blasting gelatines are condemned by the miner, and are dangerous to use on the score of misfires and incomplete detonation producing noxious gases, and are wasteful in failing to do the required work. The hypothesis, therefore, explains some facts which are common knowledge, namely that some gelatines on prolonged storage become insensitive, that the harder the jelly the more likely it is to be insensitive, and such gelatines require more powerful detonators than those in common use, and even then may not give satisfactory explosions.

Mr. C. Napier Hake, late Chief Inspector in Victoria, made the observation that if an insensitive gelatine is "remade" by mixing it with a large percentage of a fresh batch of gelatine, it will infect the mass and the remade blasting gelatine will soon undergo change and become more or less insensitive. This is explained by the above hypothesis, since the free nitro-glycerin of the new batch is added not to nitro-cotton but to an existing jelly having probably excess of nitro-cotton, and the initial trouble is perpetuated because the gelatinization at the time of re-making is thus interfered with, and goes on slowly during storage, and in the end the particles of free nitro-glycerin are either separated too far apart or are absent altogether.

The theory assumes the fact of there being free nitro-glycerin in blasting gelatine. It is difficult to get direct proof of this, but it is obvious that, since liquid nitro-glycerin can be obtained from blasting gelatine merely by pressure, and also by means of blotting paper, the nitro-glycerin is not chemically combined with the nitro-cotton. Neither could the nitro-glycerin which is thus removed have been in solution, or in the colloidal state. Hake has shown (*Jl. Soc. Chem. Ind.*, Sept. 15th, 1905) that porous wrappers will cause exudation even in the case of blasting gelatines that show no tendency to exude when in ordinary wrappers. The probability is therefore that there is generally some nitro-glycerin in the "free" or liquid state in the explosive. If the free nitro-glycerin is near the limit, the tendency to exudation will be greater than when the nitro-glycerin is smaller in quantity.

A sponge can take up a certain amount of water, but if the quantity is near the extreme limit, slight conditions such as gentle pressure will cause some of the water to drip out. By continued pressure all water, but that adsorbed on the fibers of the sponge, can be removed, and even then more water may be removed by contact with blotting paper. Further, the finer the meshes of a sponge and the greater the surface of the fibers, the greater the amount of water adsorbed, and the less is likely to drip out; so also with the blasting gelatine, the more complete the jelly the less free nitro-glycerin is likely to exude. On the hypothesis that the jelly itself is made by solution of some nitro-glycerin in nitro-cotton, the more jelly formed in this way within limits, the more free nitro-glycerin will be adsorbed, and the less enmeshed or entangled nitro-glycerin there will be, and hence the less tendency to exudation. The particles or "fibers" of the jelly being "wetted" by nitro-glycerin by surface action or capillary attraction, the free nitro-glycerin can flow or move through the jelly. Suppose the surface of the cartridge is in contact with blotting paper or porous wrappers, the flow of nitro-glycerin can continue in the meshes of the paper. The same sort of action occurs at the fold of the cartridge paper, where one thickness of paper overlaps the margin of the first fold, forming a small longitudinal tube attached along one side to the gelatine. The flow of free nitro-glycerin is "attracted" by capillary action into this tube. Thus many gelatines show a line of free exuded nitro-glycerin along the fold, and exudation does not proceed any further. Again, if this flow is checked by placing an impervious layer round the outside of the cartridge, exudation may be stopped or at any rate considerably reduced. Such a layer might be obtained by the action of a coagulant on the jelly of the cartridge. Absorbents of the nature of French chalk are apt to increase the capillary attraction, although they soak up the exuded nitro-glycerin for a time, but substances like magnesium oxide appear to coagulate the jelly surface and thus check exudation. It may be possible to find a surface coagulant which will effectively stop exudation. Blasting gelatine exuding badly has been placed in fresh wrappers and in a few days' time exudation has been as bad as ever, but if the cartridges were dusted with light magnesium oxide before they were placed in fresh wrappers, in some instances there has been practically no further exudation for several weeks. In the meantime, the explosives could be put to their legitimate use.

The theory of the constitution of blasting gelatine has

\*Paper read before the London section of the Society of Chemical Industry and published in its Journal.



already rendered great assistance in elucidating the perplexing behavior of gelatine explosives.

The extent of exudation that occurs at any given time with different cartridges, possibly of the same lot of blasting gelatine, may vary considerably. To have ready means of reference, various scales have been proposed, but the one adopted in South Australia consists of five degrees based on actual cartridges. According to the theory we assume that excessive exudation represents an unbalanced explosive, and that probably gelatinization has not been complete. Acting on this assumption, one favors lengthy storage under observation of such an explosive, and it frequently happens that when it is subsequently re-wrapped so as to remove the exuded nitro-glycerin, no further exudation takes place. It sometimes happens that re-wrapping is unnecessary, the exuded nitro-glycerin having been re-absorbed, possibly by capillary action, by the stronger gel produced by the secondary gelatinization. On the other hand, if such material is placed in new wrappers at first there is every probability of further exudation taking place before the secondary gelatinization has made any progress, and the condition of the explosive may be soon as bad as it was at first. In these circumstances, re-wrapping is not recommended unless the material is to be consumed at once.

In his report on "Composition of the Gases Caused by Blasting in Mines" (*Jl. Soc. Chem. Ind.*, 1911, 447, 1281), E. A. Mann has drawn attention to the fact that unaltered fragments of nitro-cotton can be seen in blasting gelatine. He further says that the general experience in Western Australia is that an explosive which, on landing from Europe, is soft and plastic, will after a lengthy storage in a magazine become stiff and more rigid to the touch, while the common experience is that such explosives explode only under excessive stimulus, and are very apt to leave unexploded portions in the bottom of the bore holes in mines. This is also the experience in South Australia. I suggested to Mr. Mann that the theory outlined above would explain these phenomena, and his study of the question led him to believe that it was a "rational and convincing explanation for some of the problems involved."

S. Soddy in *Arms and Explosives* (February, 1912), referring to the decrease of sensitiveness of gelatines on prolonged storage, gives the results of lead block tests, which showed that blasting gelatine with a No. 6 detonator which gave a volume of 570 to 600 cubic centimeters when first tested, at the end of twelve months' storage gave only from 420 to 430 cubic centimeters. On repeating the experiments with No. 7 detonators, all gave normal results. He sees in the theory I have suggested an explanation of these results. It seems to me that Soddy's results might be explained as follows: Assuming that during manufacture the usual plan was followed, by which a preliminary mixing of the nitro-cotton and nitro-glycerin would be made, an imperfect gel would be produced. On standing overnight, the excess of nitro-glycerin would slowly act on the already formed gel and some enclosed nitro-cotton, and at the final mixing more action would take place, but it would not be so complete as it would have been had the nitro-glycerin been thoroughly incorporated with the nitro-cotton in the first instance. The reaction would continue slowly when the explosive was put in store for twelve months. If enough

nitro-cotton had been used to prevent exudation at the time the explosive was sent out from the factory, it would in reality have too much nitro-cotton and consequently all the free nitro-glycerin would be turned to the gel form, or at any rate the remaining particles of free nitro-glycerin in the "meshes" of the gel would be too small in number or too far apart to transmit the explosive wave set up by the No. 6 detonator at sufficient velocity to get complete detonation. A No. 7 detonator, on the other hand, might give sufficient stimulus to reach from one particle of nitro-glycerin to another and so give normal results.

In this connection, it is interesting to revert to Comey's experiments on rate of detonation. In determining the rate with nitro-glycerin, when  $\frac{1}{4}$ -inch bore glass tubes were used for holding the nitro-glycerin, the explosive wave was not transmitted. The column could only be detonated for a few inches from the detonator. The velocity of detonation when  $\frac{3}{4}$ -inch glass tubes were used was only 654 meters per second, while with 1-inch light sheet iron tubes two kinds of explosive wave were obtained, one with a velocity of only 1,451 meters, while the other was about 7,690 meters, which is comparable with the rate given by nitro-glycerin in No. 1 dynamite. With wrought iron tubes of  $1\frac{1}{2}$ -inch diameter, a 24-grain cap gave a velocity of 8,527 meters while a 12-grain cap gave only 2,019 meters. Where paper tubes were used, the rate was lower, probably on account of the smaller confinement of the nitro-glycerin charge. Applying the theory, we see that if the particles of free nitro-glycerin are in continuous "threads" or surfaces sufficiently large in diameter or area and thickness, the explosive wave should be transmitted in blasting gelatine at a rate which would be directly comparable with that of nitro-glycerin. If, however, the surfaces are thinner or the threads finer, the rate would be less, and may be interfered with and brought as it were to a lower octave of vibration by the buffer action of the gel. Two or more separate rates of detonation may be obtained.

When testing explosives imported into Western Australia, Mann found that some blasting gelatines gave rates of from 3,759 to 4,225, averaging 4,063 meters per second, whereas others gave from 2,400 to 2,553, averaging 2,457. The last figures suggest that very little free nitro-glycerin remained in these blasting gelatines, or that such particles as remained were not in contact, but were effectively screened by the intervening gel.

The late W. R. Quinan was of opinion that a maximum rate of detonation implied a perfect detonation, whereas an abnormally low rate denoted insensitiveness and probably incomplete metamorphosis. In America generally, according to Soddy, a sharp detonation is preferred, which means a high rate of detonation. If one desires a lower rate, one uses some other explosive than blasting gelatine. It is, therefore, now suggested that the blasting gelatine which has the most free nitro-glycerin, has the greatest rate of detonation, and that it is not the extra gelatinization which takes place on storage that makes a blasting gelatine inert, but the lack of free nitro-glycerin. Consequently that blasting gelatine is the best which

(1) Has the most free nitro-glycerin, provided that the free nitro-glycerin is so held by the gel (by adsorption or otherwise) that the finished explosive is free from all liability to liquefaction or exudation; and

(2) Has all its nitro-cotton completely gelatinized, so

that there will not be any reduction of the amount of free nitro-glycerin on storage by secondary gelatinization.

The question now arises as to what use the manufacturer can make of the hypothesis. In my opinion, it should at least serve as the basis of carefully conducted experiments. In 1909 and 1910, I suggested to the representatives of several manufacturers that experiments should be carried out by thoroughly mixing in the cold, nitro-cotton with quantities of nitro-glycerin much short of the total required to form ordinary blasting gelatine, and then after gelatinization, the further quantities of nitro-glycerin to make up the total should be mixed with the existing jelly. I also suggested that the thoroughness of the preliminary mixing should be varied. My own experiments with wheat flour and water indicated that it is one thing to add water to flour, and a different thing to add water to a dough. Hence, in determining the water absorption of flour it is necessary by preliminary trials to ascertain approximately the amount of water required to make a standard dough, and then to make the actual determination by adding the whole of the water to the flour in one operation. This is not the usual method, which is to add some water and make a dough; if this dough is not the right consistency, more water is added little by little until it is right. This gives a fallacious result, because the small lots of water being added in this way are added to a dough, and remain as free water in the interstices of the dough for a considerable time. Where the water is added all at once, every particle of flour gets its quatum of water before the gel is formed. From analogy with the action of flour and water, assuming the presence of free (ungelatinized) nitro-glycerin in blasting gelatine, the remedy for exudation is therefore not to add more nitro-cotton, but to get a larger amount of gelatinization during the initial mixing of the nitro-cotton and nitro-glycerin. To obtain this result, more thoroughness is necessary in the preliminary mixing, and also immediate and thorough working in a machine is required. I suggest that the remedy for insensitiveness is to reduce the quantity of nitro-cotton and make up for this by more complete mixing, especially in the preliminary stage. One of the manufacturers took the matter up with enthusiasm. There had been trouble on account of exudation. My suggestions respecting thoroughness of the initial mixing were acted upon and the result was a surprising success. It was not known here that any change in the method of manufacture had been made, but the improved quality of the blasting gelatine excited questions and the reply was that "most of the success of the last shipment is due to modified methods of mixing during manufacture, the benefits of which were first brought to our notice by you."

Another manufacturing company discussed the question with me in 1910, and subsequently made a trial of the new direct method of obtaining gelatinization. This year the company reports that "at one time, it was not thought possible to manufacture a satisfactory gelatine without overnight standing and final hot gelatinization, but we have been able for some little time to obtain exceedingly good results by direct gelatinization after mixing nitro-glycerin with the nitro-cotton."

It is still too early to say that this modification in manufacture will cure the exudation trouble, but the results so far obtained are very encouraging.

### Disease Dangers of Mexican Invasion

THE possibility of war with Mexico has been before our people for some time; if a general war occurs it means invasion of Mexican territory. The question naturally arises: "What are the disease dangers which will confront American soldiers in Mexico?" It has long since passed into a truism that in war, disease kills more than bullets. Will this prove true in a Mexican war? The increased knowledge of preventive medicine since the Spanish-American war has encouraged the belief that the mortality from disease will be materially lessened. To what extent is this belief justified, and what are the diseases from which our troops may suffer in a tropical country and from which they should be protected?

Aside from the ordinary diseases which might prevail among any body of two or three hundred thousand men, there are certain diseases to which soldiers in camp and in the field are particularly exposed. These are especially small-pox, typhoid fever and dysentery. Small-pox may be disregarded, as any troops sent into Mexico will be immune from this disease through vaccination. Typhoid fever, in the past, has been the awful scourge of military camps. The appalling experience of the Spanish-American war has not been forgotten by our people; the record of twenty thousand cases of typhoid in the Army in six months produced an impression which can never be obliterated. But since then progress in preventive medicine has been made, and vaccination against typhoid is a result. Anti-typhoid inoculation has been subject to rigorous tests

on a large scale in the Army during the past two years, with the result that in 1913, out of ninety thousand men at home and abroad, there was only a single case of typhoid fever among the inoculated, a record that can well be regarded as a triumph for preventive medicine. It is believed that the army surgeon now has a weapon against typhoid that will make the next war unique in this regard. Every officer and man now in the United States Army and Navy is practically safe against this disease, and each recruit will be inoculated at the time he is sworn into the service. The next campaign in which the United States Army will participate will be a practical test of typhoid prophylaxis on a large scale. That it will prove the value of inoculation and will relieve warfare of one of its most horrible accompaniments there is little doubt.

The dysenteries can be divided into those due to bacterial invasion and those caused by ptomaines in foods. While the water and food of the soldiers will be more carefully guarded than ever before, a certain amount of intestinal disorder will be inevitable. It can safely be predicted, however, that the nation will be spared a repetition of the "embalmed-beef" scandals of 1898. The work of the general staff of the Army, the development of departmental officers of high efficiency and the enormous amount of publicity on pure food that has taken place in the last decade, ought to insure the American soldiers a wholesome food-supply. After the experience and warning of the past, the American people will hold to a strict accountability any one responsible for supplying the

Army with food materials which are not in every way up to the standard.

Of the diseases peculiar to tropical and semi-civilized countries, yellow fever, malaria, bubonic plague, cholera and typhus must be considered. The brilliant work of the last fifteen years in demonstrating the transmission of malaria and yellow fever by the mosquito has put our Army and Navy surgeons and sanitarians in possession of all the knowledge needed to control these diseases. The convincing demonstration of the practicability of their control given by General Gorgas in the Canal Zone has proved that malaria and yellow fever can be controlled completely in settled communities. Where men are living in fixed habitations which can be screened and where all possible breeding-places of mosquitoes for a necessary distance can be destroyed, the complete eradication of these two diseases is possible. It remains to be seen, however, what methods can be developed for preventing mosquito infection among soldiers in the field. Mosquito-nets can, of course, be carried, and patients in the field and hospitals can be protected as well as troops in barracks or permanent quarters. But how about troops in the field, scouting parties, pickets and outposts? Undoubtedly American ingenuity will devise methods to meet the needs, and the dangers of these two diseases will be greatly diminished, although occasional cases may be unavoidable. Epidemics, however, will be practically impossible.

Cholera, being borne through water, milk, flies or human carriers, can be prevented only through clean-



liness and by maintaining the purity of water-supplies. It is not to-day a particularly dangerous possibility, as it can enter Mexico only by way of the seaports, most of which, in case of a campaign, would soon be in the hands of the Navy and under quarantine regulations. Regarding typhus fever, it is a strange coincidence that the work of Ricketts, by which he demonstrated, at the loss of his own life, that the body-louse is the carrier of this disease, was done at Mexico City, where he went to carry on his investigations on account of the prevalence of typhus among the lower-class Mexicans. This disease, which in past centuries caused enormous loss of life in camps and on shipboard, is limited in its danger and can easily be prevented by avoiding dirty dwellings and contact with dirty individuals. There is as yet no known method of prevention except the avoidance of infection. It is probable that among any large number of soldiers in Mexico, a few cases of this disease will develop.

Bubonic plague is endemic in many of the near-by South American ports. It would probably be a constant danger in the Mexican seaports. Fortunately, it would be confined largely to the seaports and large towns. An army in the field, living in tents on the bare ground, would be practically safe from it. Probably one of the first measures inaugurated by our medical officers on taking possession of a Mexican seaport would be a campaign of rat extermination, as this animal has been shown to be responsible for plague propagation.

These are the principal dangers to American soldiers in Mexico. Our equipment for the control of these diseases is not yet entirely complete, but the enormous increase in scientific knowledge and the equally marked development of practical methods for fighting diseases in the last fifteen years justify the assurance to the American people that the horrors of epidemic disease in past wars will be impossible in our next military experience. The United States possesses to-day in the medical officers of the Army, Navy and Public Health Service a body of trained and expert sanitarians equal to any in the world. Whatever human knowledge and skill can do to protect our soldiers from diseases will be done, and it can safely be said that any army that we may send into foreign territory will be better protected against disease than has ever before been the case in our history.

—Journal of the American Medical Association.

### Forest Fire Prevention

#### Efforts of Railway Company to Prevent Ignition by Locomotive Sparks

THE problem of avoiding the danger of forest fires along its lines has for some time engaged the attention of the New York, New Haven & Hartford Railroad. While various mechanical devices have been suggested with this end in view, experiment has demonstrated to the satisfaction of the road that the best way to accomplish this is to clear of underbrush a fairly wide strip of land adjacent to the right of way. To do this it is necessary either to obtain permits from the owners of the land or to buy it outright.

The road has now received the bulk of the necessary permits for such work. Within the past month it has begun an active campaign to clear all of its lines in such districts and thus eliminate the danger of fire. Recently an appropriation of \$2,500 was made for this purpose. At the present time work is being concentrated chiefly on Cape Cod. Two "brush gangs" of 25 men are now at work between Yarmouth and Brewster. When this 20-mile stretch has been cleared it is proposed to tackle the section between Harwich and Chatham.

It is recognized that forest fires are a cause of serious economic loss, and while sometimes an unavoidable incident of railway operation, it is most essential to reduce the chance of them to a minimum. Conditions which the New Haven faces in the Cape Cod district in Massachusetts are somewhat exceptional. There a dry and sandy soil, combined with a peculiar growth of vegetation, increases the danger of fire over what is usually found in wooded sections. To these conditions has been added the drought which has prevailed now in this part of the country for some years, causing the rainfall to fall far below the normal.

Outside of the Cape, the principal wooded section where forest fires occur are in Plymouth, Bristol and Hampden counties in Massachusetts, in western Connecticut and in part of Rhode Island.

It was recently estimated that of the New Haven's total mileage about 500 miles lie through country where there is more or less danger from such fires. Of this 500 miles about 200 miles have already been cleared at least once. In Barnstable County, which covers Cape Cod, at least 50 miles lie through the "fire district." Within a short time it is hoped to clear all of these lines.

The method which the New Haven is now following is the result of the success of experiments made in recent

years on a 7-mile stretch between Myricks and Middleboro in Massachusetts. On this stretch—one of the worst in its territory—an average of 20 fires a year, requiring payment of damage, had occurred for several years. Since this stretch was cleared five years ago there has been no fire at all upon it.

A strip adjacent to the railroad's right of way through the Douglas Woods, in Rhode Island and Connecticut, was also cleared some years ago with similar results. More recently a large amount of clearing has greatly reduced the fires in Plymouth County, Mass.

The efforts of the New Haven to reduce the fire danger by this clearance method really began as far back as 1900, when it commenced buying land or obtaining permission to clear it in forest sections. Between 1900 and 1905 about 200 acres, mostly east of Willimantic, were purchased. Within the last five years the company has bought probably 500 acres just for the purpose of keeping it clear of underbrush and so preventing fire. These purchases have been chiefly in the Cape Cod district, between Plymouth and Middleboro, Fall River and Middleboro, Taunton and Middleboro, South Dennis and Middleboro and Braintree and Plymouth.

Purchases of land have also been made between East Greenwich and Westerly on the main line, and from Congamond Lake to Conway, Mass., on the Northampton Division. In the Berkshires no land to speak of has been purchased, but many permits have been obtained.

The aim of the railroad is to acquire, either by purchase or permit, the right to clear a strip at least 66 feet wide on straight track and 132 feet wide on curves, the spark radius on curves necessarily being much greater than on straight track. These strips are first cleared completely of all small growth and underbrush by the "brush gang," and are then kept clear by the section men. All trees are left standing, because trees act as a screen and protection against fires, and sparks dropping on leaves and needles are soon extinguished. It is the underbrush and dry grass which cause these forest fires.

In Plymouth and Barnstable counties in Massachusetts the forests are chiefly of pitch pine and a small growth of white oak. The timber is not as heavy as railroads encounter in other parts of the country, but the soil being light and sandy instead of damp, grass and leaves dry up very quickly and easily catch fire. But once all the underbrush has been removed for a sufficient width either side of the track, there is really little chance of a fire being started.

In the summer of 1912 only two inches of rain fell in this section. Last summer's rainfall showed only a slight increase. On account of the condition on Cape Cod last summer the New Haven had a motor car with four men follow every train during the drought to look out for and extinguish fires before they made any headway. This plan will probably be followed this summer.

On several of its lines, in the bad seasons of the year, the company maintains a fire patrol system. This is true of the Litchfield Branch south of Washington, some of the Pascoag and Attleboro branches and the main line. On the Midland Division during the worst season the regular section gang patrols especially for fires. On portions of the Danbury and Northampton branches and New York Division arrangements are being made with property owners for burning over the underbrush outside the right of way.

The Central New England, in order to reduce the danger of forest fires, is co-operating with the Connecticut State Forestry Department in installing telephones for the use of the State every eight or ten miles along portions of its lines in Connecticut.

All of the locomotives of the New Haven are equipped with a spark-arresting device approved by the Massachusetts Commission. This is a wire mesh arrangement designed to catch sparks. Under the rule of the company these must be inspected at every trip of a locomotive, and if any holes have been burned in this mesh the locomotive is supposed to be repaired immediately. The New Haven, in common with other roads, is experimenting with all promising devices for arresting smoke and sparks to ascertain if the present device may be improved upon.

The work of reducing the fire hazard to a minimum by the clearance method cannot, of course, be accomplished all at once. It is confidently expected, however, that within two years the results will be such as to demonstrate that this method is by far the most practical and effective for saving woodland from destruction.

### The Stars in Daylight

By Arthur Pahl

THE following short notes represent an attempt I made some time ago to see a few celestial objects in daylight. The observations were made March 14th, 1911, between the hours of 4 P. M. and 5 P. M. As the telescope did not have circles, the objects had to be "swept

up" with a low power, the operation being rather a difficult one, since the instrument had to be focused by guesswork.

Rigel was the first object located, and the companion could be seen as easily as Rigel itself. Both stars were of the same color, bluish-white, and appeared clean, without a trace of diffraction rings. Eta Orionis was found next, and with a magnification of 252 diameters presented a beautiful appearance, the stars showing as two sharp dots, and nothing else. Zeta was soon double, but the third star, of the tenth magnitude, was invisible. Sigma was observed to be triple, and the three 8.5 magnitude stars preceding were easy, presenting the smallest imaginable points. Iota was triple; the outer companion is rated smaller than the comes to Zeta, but it is evident that this is not so. And then came the "Trapezium" (Theta Orionis); the four stars were there, sharp and clear, and without a trace of the nebula. It was a queer sensation to see this familiar object free from its "filmy veil," which presents so complex and extraordinary a structure on a black sky. Lastly, the telescope was turned upon Venus, but, although the disk appeared beautifully sharp with 504 diameters, not a trace of markings could be seen, and the terminator appeared even. Thus ended an "excursion" among the stars in daylight.

The telescope used in making the foregoing observations was my 14-inch reflector.—*English Mechanic and World of Science.*

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

We also have associates throughout the world, who assist in the prosecution of patent and trade-mark applications filed in all countries foreign to the United States.

MUNN & Co.,  
Patent Solicitors,  
361 Broadway,  
New York, N. Y.

Branch Office:  
625 F Street, N. W.,  
Washington, D. C.

## SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, MAY 23, 1914

Published weekly by Munn & Company, Incorporated  
Charles Allen Munn, President; Frederick Converse Beach,  
Secretary; Orson D. Munn, Treasurer  
all at 361 Broadway, New York

Entered at Post Office of New York, N. Y., as Second Class Matter  
Copyright 1914 by Munn & Co., Inc.

#### The Scientific American Publications

Scientific American Supplement (established 1876) per year \$5.00  
Scientific American (established 1845) . . . . . 3.00  
American Homes and Gardens . . . . . 3.00

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

#### Table of Contents

	PAGE
House-flies and Disease.—By Edward Halford Ross.....	322
Wave-action on Harbor Breakwaters and Piers.—By E. R. Matthews.—17 illustrations .....	324
Marble Light, The.—By W. Voegle.—3 illustrations.....	326
Chapter of Ancient American History, A.—By Herbert J. Spinden.—21 illustrations .....	328
Strength of Shafting Required to Transmit a Given Horse-power at Different Speeds.—By C. H. Clark.—1 illustration .....	331
Plasmodium Tenue, a New Malarial Parasite of Man..	331
Some Statistics on German Universities .....	331
Life Habits of Fishes, The.—By Bashford Dean.—4 illustrations .....	332
Trees as Windbreaks for Land Under Cultivation.—2 illustrations .....	333
Whales in the Mediterranean .....	333
Origin of a Borax Mineral, The .....	333
Blasting Gelatine: Some Notes and Theories.—By W. A. Hargreaves .....	334
Disease Dangers of Mexican Invasion .....	335
Forest Fire Prevention .....	336
Stars in Daylight, The.—By Arthur Pahl .....	336



rather a  
eused by

mpanion  
ars were  
d clean,  
onis was  
iameters  
showing  
was seen  
ide, was  
and the  
present-  
s triple;  
comes to  
nd then  
ur stars  
e of the  
familiar  
so com-  
ck sky.  
but, al-  
uth 504  
en, and  
"excur-

bserva-  
mic and

re in a  
branch  
mposed  
thor-  
ent ap-  
of the  
hical,

d, who  
rk ap-  
United

ay,  
N. Y.

AN

ed  
Beach,

Matter

\$5.00  
2.00  
3.00

tries

eck  
York

blish  
stin-  
arti-  
and  
ught  
l.

PAGE  
222

224  
326

328

331  
331  
331

332

333  
333  
333

334  
335  
336  
338